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OCTOBER 1934

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CORRECTIONS

Volume 62, July 1934, page 235, first column, 3rd line from top, "less" should be "more"; same line, "1930" should be "1938"; page 237, the *legends* to figures 4 and 5 should be *interchanged;* page 240, table 1, in the column headed "Third quarter" the three entries, reading down, should be "−0.35", "0.75", and "4.7", respectively.

MONTHLY WEATHER REVIEW

Editor, W. J. HUMPHREYS

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QUARTERLY FORECASTS OF SEA AND AIR TEMPERATURES

By GEORGE F. MCEWEN

Professor of Physical Oceanography

[Scripps Institution of Oceanography, La Jolla, Calif., October 1934]

ABSTRACT

Reliable forecasts of monthly air and sea temperatures one or several months in advance, and a general idea of the probable temperatures for a year in advance, are in great demand. In fact, attempts to provide such information for commercial purposes are made by various individual organizations, utilities, department stores, sea products companies, etc. May we expect to be able to work out such forecasts with sufficient reliability to be of commercial value?

While no adequate physical theory for guidance in such problems has been developed, it seems reasonable to assume the existence, at least in some regions, of factors which influence to a greater or less extent the temperature trend a few months in advance. In searching for the proper factors it is assumed that a composite index to them, of forecast value, is furnished by past temperatures. Proceeding empirically on this basis, the monthly temperatures are "smoothed" or adjusted in order to eliminate the irregularities which at first are regarded as accidental. Projecting these smoothed values a few months in advance in accordance with past variations, and correcting the seasonal changes for systematic errors introduced by the smoothing process, we obtain an empirical forecast. Such a procedure has been applied to observations in southern California that extend over a period of about 20 years, in order to compare the computed and observed temperatures. A very definite correlation was found; a temperature forecast 3 months in advance, by this method, departed from the actual by more than a degree in only 10 percent of the cases for sea temperatures at La Jolla. Air temperatures at Riverside were thus forecast to within 2° of the actual in about 90 percent of the cases. The success of such an empirical procedure depends upon the stability of the general temperature trends. The limited experience with this method in southern California indicates that it is of sufficient reliability to be useful economically in that region.

There is evidence of a 4-year temperature cycle, the last minimum being in 1933. The general upward trend thus indicated from 1933 to 1935 is in accord with the 3 months' forecast of higher than average temperatures for the summer of 1934.

Variation of average monthly temperatures of both the sea and air may be regarded as the result of regular, well-defined trends in causes, accompanied by accidental disturbances. Occasionally a major disturbing factor may arise and result in a correspondingly great departure of temperatures from an orderly trend. An appropriate smoothing process applied to observed monthly temperatures reduces the irregular accidental variations to a minimum. Assuming these smoothed temperatures to form a composite index of the regular trends in causes, various methods of extrapolation can be applied to predict the future smoothed temperature; and its comparison with smoothed values of observed temperatures tests the validity of the assumptions. Corrections to eliminate systematic effects of the smoothing process, especially the reduction of seasonal amplitude, should be calculated for the predicted smoothed temperatures. The difference between values thus corrected and observations will be due to lack of agreement between actual conditions and the underlying assumptions, and may have a regular trend to which are added accidental departures which cannot be eliminated.

The smoothed value of the middle one of a series of 21 terms, calculated by the Spencer 21-term formula,[1] was used in this study. If, as is usual, an inspection of the smoothed observed values indicates a tendency toward repetition of certain sequences, the series can be extended beyond the last observation by selecting an earlier sequence agreeing approximately with the last one. It is desirable to make more than one such selection. Then the smoothed series can be extrapolated beyond the last observation:

Making use of only the smoothed results terminating with the last observation, various methods of two-way extrapolation can be applied; the simplest is to use the

[1] Spencer's 21-term formula (Whittaker and Robinson, Calculus of Observations, p. 290; Rietz, Handbook of Mathematical Statistics, p. 59) applied to a third degree polynomial function, with equal intervals of the independent variable, does not change the original values. In general it tends to give a smooth graduation. If applied to a sine function, it reduces the amplitude and thus tends to suppress cyclical variations. However, this tendency is most pronounced for small periods, especially those less than 10. To apply this method:

(1) Compute progressive sums, 7 at a time.
(2) Compute progressive sums of these results, 5 at a time.
(3) Compute progressive sums of these results, 5 at a time.
(4) Compute the weighted progressive sums of these results, 7 at a time, with the following weights: −1, 0, 1, 2, 1, 0, −1.
(5) Divide the last result by 350, which equals 7×5×5×2, to obtain the smoothed value.

Exactly 21 terms are required for each smoothed value, which corresponds to the middle term of the series.

The weighted progressive sums, 7 at a time, can also be calculated first, then the two, 5 at a time in succession, and finally the progressive sums, 7 at a time. To illustrate the computations, both methods are here applied to the same series:

	(7)	(5)	(5)	Weighted sums (7)	Smoothed values		Weighted sums (7)	(5)	(5)	(7)	Smoothed values
52						52					
72						72					
60						60					
72	420					72	160				
60	428					60	112				
52	416	2064				52	96	584			
52	416	2020				52	84	560			
60	384	1980	9924			60	132	552	2780		
60	376	1944	9780			60	136	544	2708		
60	388	1916	9688			60	104	540	2648		
40	380	1920	9644	18952	54.14	40	88	512	2628	18952	54.14
52	388	1928	9656	19012	54.32	52	80	500	2652	19012	54.32
64	388	1936	9692			64	104	532	2732		
44	384	1956	9756			44	124	568	2804		
68	396	1952	9856			68	136	620	2840		
60	400	1984				60	124	584			
56	384	2028				56	132	536			
52	420					52	68				
56	428					56	76				
48						48					
80						80					
76						76					

Various special methods can be used for smoothing the 10 values at the beginning and end. One method is explained in "The Smoothing of Time Series", by F. R. Macaulay, National Bureau of Economic Research, No. 19, 1931.

multipliers −1 and 2 for the last 2 values, and the multipliers 1, −2, and 1 for the 3 corresponding values in the preceding year. For example, table 1, lines 2 and 3, presents smoothed monthly air temperatures at San Diego for 1932 and 1933, where the last month of observations was September 1933. Observations in the year 1921 were used to extend the series. The extrapolated value in line 4 for October was calculated as follows:

$$17.95-2\ (17.50)+16.62-17.32+2\ (\underline{17.12})=16.18$$

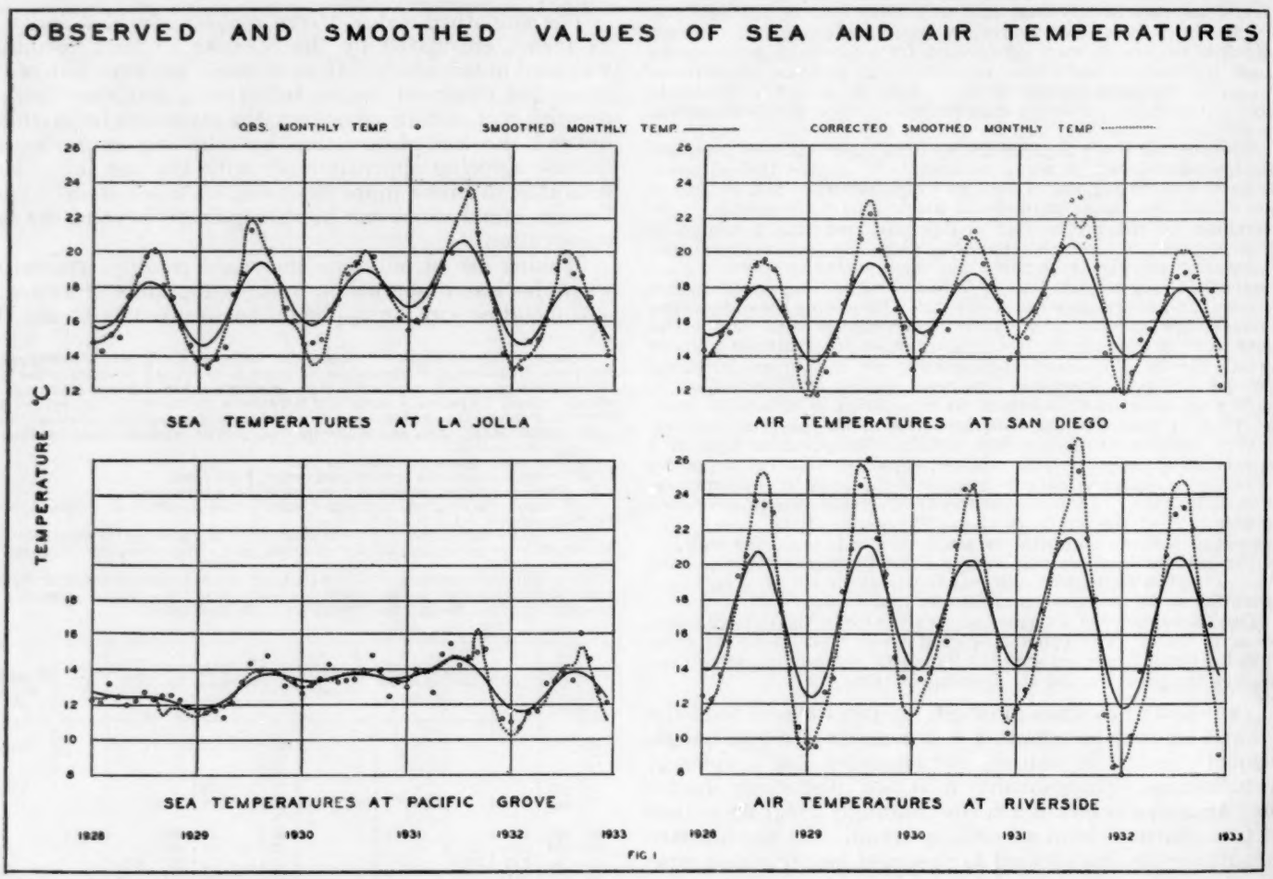
TABLE 1.—*San Diego air temperatures*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
[2]	14.17	14.11	14.30	15.28	16.33	17.28	17.86	17.95	17.50	16.62	15.58	14.58
[3]	13.83	13.54	13.72	14.39	15.32	16.28	17.00	17.32	17.12	16.47	15.52	14.56 [1921]
[4]								17.23	16.92	16.18	15.28	14.42
[5]	Forecast: from line 4									17.10	15.30	13.10
[6]	Observed									16.89	16.33	12.83

integral. Divide the monthly values into two equal groups, one centering about M_1 and the other about M_2. Then find the ratios $(O-M_1)\div(S-M_1)$ and $(O-M_2)\div(S-M_2)$ for each month, where O=average monthly value. To obtain any corrected value, multiply $(S-M_1)$ or $(S-M_2)$ by the value of the ratio R corresponding to that month. Original monthly temperatures shown by the points in figure 1 should be compared with the full lines representing smoothed values, and the dotted lines representing smoothed values corrected for curvature.

Of the various groups of multipliers that can be used for extrapolating, four are shown in figure 2, which also presents data on the reliability of smoothed values forecast 3 months in advance.

A summary of forecasts from 1 to 4 months in advance is shown by figure 3, where a vertical line is drawn after the last month of observations used in making the forecasts represented by the portion of the full line extending



The same multipliers were applied to values 1 month later, *using 16.18*, to obtain 15.28 for November; and so on. The agreement between the values thus extrapolated and the values of the extended series checks the selection of the sequence. These extrapolated smoothed values corrected for curvature, and entered in the next line, are forecasts of monthly temperatures; the temperatures later observed are entered in the last line for comparison. The curvature corrections were made by means of a table computed as follows:

Smooth the average monthly values for the whole series of years. In general there will be two times in the cycle at which the average monthly values M_1 and M_2 equal the smoothed values. These times may not be to the next vertical line. The distribution of the differences between these observed and forecast values is presented in table 2.

TABLE 2.—*Distribution of the 93 departures between temperature forecasts and observations*

Departure (° C.)	0.4	0.8	1.2	1.6	2.0	2.4	2.8
Percent less than the departure	27	51	68	80	84	87	90

An examination of the mean monthly air temperatures predicted 3 months in advance over a period of 16 years shows that for Riverside, in 55 percent of the cases the error was within 0.5° C; in 74 percent of the cases the error was within 0.7° C.; in 90 percent of the cases the error was within 1.1° C.

The unusually high temperatures at Riverside and especially Sierra Madre during October and November 1933 were caused by local dynamic heating; that is, by a downflow of air in that region, which was heated as it was compressed. This condition, which is associated with the barometric pressure distribution, should be given special attention in making such temperature forecasts, especially during September, October, and November, but was not taken into account in this study.

The following supplementary graphical procedure, providing a general "outlook" of temperatures over longer periods of 6 months, has been helpful: Eliminate the seasonal variation from the smoothed temperatures by computing averages of successive sums of 12 observations, and plot the corresponding temperature curve, called the "sum-12" curve, using all of the available observations. Experience has shown that the departure of the seasonal minimum temperature of the smoothed curve from the sum-12 curve tends to a different average value near low points of the latter from that at high points. This is also true of the departure of seasonal maximum temperatures. Accordingly, projecting the sum-12 curve, and plotting the departure of seasonal minimum and of seasonal maximum temperatures estimated for the plotted values of the sum-12 curve, provides a generalized forecast.

In general, the various mathematical methods of forecasting outlined in this paper appear to be useful tools when applied with judgment, and checked for consistency. The limited experience with this procedure in Southern California indicates sufficient reliability to be of commercial value in that region.

EXTRAPOLATION OF SMOOTHED TEMPERATURES AND TESTS OF THEIR ACCURACY

FOUR GROUPS OF FACTORS FOR COMPUTING THE SMOOTHED TEMPERATURE 1 MO. IN ADVANCE

+1	-2	+1
-1	+2	X

-1	-1	+2
-1	-1	+2
+2	+2	4X

-1	+2	-1
+2	-4	+2
-1	+2	X

-1	+3	-3	+1
+1	-3	+3	X

DEPARTURES FROM SMOOTHED TEMPERATURES OF THOSE FORECAST 3 MO. IN ADVANCE

PERCENTAGE LESS THAN TABULATED DEPARTURE

DEPARTURE	°.25	°.50	°.75	1°.00	1°.25	1°.50
RIVERSIDE AIR	19	45	63	78	88	94
LA JOLLA SEA	42	69	87	97	100	

CORRELATION OF SMOOTHED RIVERSIDE AIR AND LA JOLLA SEA TEMPERATURES WITH FORECAST

MEAN - SMOOTHED TEMPERATURES

MEAN - THREE MONTHS FORECAST

	-2.1 -1.5	-1.5 -.9	-.9 -.3	-.3 .3	.3 .9	.9 1.5	1.5 2.1		
3.9 3.3							1		1
3.3 2.7						2	0		2
2.7 2.1				1	0	1	1		3
2.1 1.5			1	2	3	4	0		10
1.5 .9			2	5	12	4	1		24
.9 .3			9	13	13	3			38
.3 -.3			6	15	13				34
-.3 -.9		4	10	16	4				34
-.9 -1.5	1	3	19	8	2				33
-1.5 -2.1	2	4	6	0					12
-2.1 -2.7	3	2	1	1					7
-2.7 -3.3	1								1
	7	13	54	61	47	14	3		199

MEAN - SMOOTHED TEMPERATURES

MEAN - THREE MONTHS FORECAST

	-2.7 -2.1	-2.1 -1.5	-1.5 -.9	-.9 -.3	-.3 .3	.3 .9	.9 1.5	1.5		
2.7 2.1							2			2
2.1 1.5						6	5	1		12
1.5 .9					2	17	3			22
.9 .3					15	23	3			41
.3 -.3				2	32	8				42
-.3 -.9			8	13	8	1				30
-.9 -1.5		1	4	15	1					21
-1.5 -2.1		3	1	2						6
-2.1 -2.7		5	2							7
-2.7 -3.3	2	2								4
	2	11	15	32	58	55	13	1		187

FIG. 2

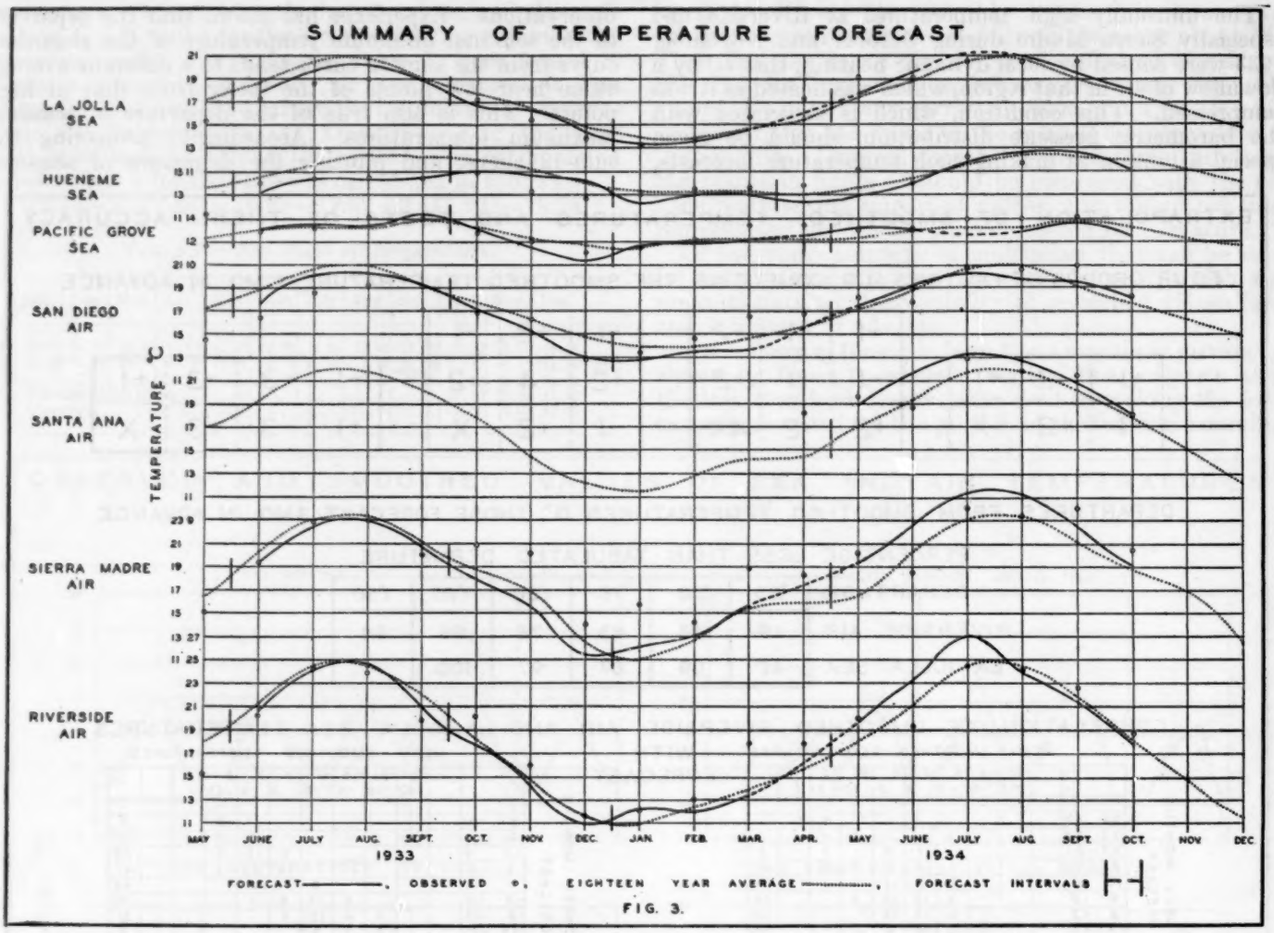

SUMMARY OF TEMPERATURE FORECAST
LA JOLLA SEA
HUENEME SEA
PACIFIC GROVE SEA
SAN DIEGO AIR
SANTA ANA AIR
SIERRA MADRE AIR
RIVERSIDE AIR
TEMPERATURE C
MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC
1933
1934
FORECAST———, OBSERVED ○, EIGHTEEN YEAR AVERAGE ·····, FORECAST INTERVALS

FIG. 3.

AN INTERNATIONAL COMPARISON OF STANDARD BAROMETERS

By S. P. FERGUSSON

[Read before the American Meteorological Society, Atlantic City, Dec. 28, 1932; revised, September 1934]

For the measurement of short-period or day-to-day changes of atmospheric pressure and for almost all other purposes of meteorology and engineering, simple mercurial barometers of the "station" type having tubes about 6 mm in diameter are sufficiently accurate. But when pressures in different parts of the world are to be compared, and changes during long periods of time analyzed, instruments of greater precision become necessary; consideration must be given to the materials of which they are made and the slight variations of condition (chiefly of the vacuum) occurring in almost all barometers, even those of superior construction, through periods of many years. The only method of securing uniform, comparable records is that of comparing working standards, station or observatory barometers in current use, with "normal" or primary standards, the vacuum of which can be controlled and measured with high precision under "laboratory" conditions. Primary standards are costly and must be operated by trained physicists; but their importance is indicated by the design and use of several excellent examples in various countries of Europe.

In America, until recently, the sole dependence for international comparisons of pressures has been a few large-bore instruments of the Fortin type adjusted to agree with normals at the Kew Observatory, England, or similar instruments in France and Germany. One of the best examples is that of the importation, in 1878, by the United States Signal Service, under the most careful supervision, of 10 barometers by Adie of London, 4 of which are still used as standards by the United States Weather Bureau; another is the purchase by Professor Rotch of similar instruments by Hicks of London (no. 818 in 1885, no. 872 in 1887, and no. 1019 in 1892), for use at Blue Hill Observatory; and a third is that of an English barometer employed recently by the Canadian Meteorological Office in a comparision with the official standard of Canada; all of these instruments were certified at Kew. The Adie barometers and Hicks nos. 818 and 1019 have 12 mm tubes; that of no. 872 is 15 mm in diameter.

When Blue Hill Observatory was opened in 1885 the standard barometer was Green no. 2677, an instrument of the "station" type having a 6 mm tube, corrected to agree with the Signal Service standard, which, as stated, was that of Kew Observatory determined by means of the Adie barometers of 1878. Since January 1886 the standard of pressure has been that of Kew based upon the Hicks barometers of 1885, 1887, and 1892.

Differences developing among the barometers at Blue Hill, and between the standards of the Weather Bureau and Blue Hill during the period 1885 to 1892, led to the

importation of the third standardized barometer in 1892, which, three times (1893, 1909, and 1932), has been taken to Washington for comparisons with the standards of the Weather Bureau, and once (1932) to Toronto for comparisons with the Canadian standard.

In March 1932 the Harvard Institute for Geographical Exploration imported an excellent instrument (Casella, no. 3289, having a 10 mm tube), of the type in use at Blue Hill, and in February 1933 another (Casella, no. 3306, having a 5 mm tube) of the pattern used on high mountains; the latter has a Kew certificate. These instruments have been used in a fourth comparison of American and English standards in which were included 4 instruments at Blue Hill, 3 at the Geographical Institute, 3 at the Weather Bureau, and 1 at Toronto. The Blue Hill standard of 1892 (Hicks, no. 1019) was first carefully compared with the other three instruments at Blue Hill; then, in succession, with the instruments at the Geographical Institute, the Weather Bureau and the Canadian Meteorological Office; after which it was recompared with the standards at the Geographical Institute and Blue Hill to ascertain whether changes had occurred during the journey to Washington and Toronto.

The usual precautions were observed during this series of comparisons: in every instance where Hicks no. 1019 was taken to another place it was exposed near the other barometers the day before actual observations were begun, the conditions of temperature, etc., kept as uniform as possible, and two or more series of about ten readings each were made on different days. Except at Toronto, the several groups of readings were made by different observers.

The following summary is offered: Hicks no. 1019 (1892), compared with Casella no. 3289 (1932), at the Institute for Geographical Exploration:

Before no. 1019 was taken to Toronto; means of 2 series of 10 readings of each instrument:

No. 3289	No. 1019	Difference	Corrected difference
Inches	*Inches*	*Inch*	*Inch*
29.8204	29.8222	−0.0018	+0.0012
29.2521	29.2524	+.0003	+.0027

After no. 1019 was brought back from Toronto and Washington; 1 series of 9 observations.

No. 3289	No. 1019	Difference	Corrected difference
Inches	*Inches*	*Inch*	*Inch*
30.3686	30.3673	+0.0013	+0.0043

Hicks no. 1019, compared with standard of United States Weather Bureau; 3 series of 10 readings each: Weather Bureau −no. 1019:

	Series 1	2	3	Mean
	Inch	*Inch*	*Inch*	*Inch*
Actual mean	−0.0095	−0.0055	−0.0081	−0.0077
Corrected mean	−.0065	−.0025	−.0051	−.0047

Hicks no. 1019, compared with Newman standard of the Canadian Meteorological Office, Toronto; 2 series of 10 readings each:

	Newman	No. 1019	Difference	Difference, after applying corrections
	Inches	*Inches*	*Inch*	*Inch*
1	29.778	29.786	−0.008	−0.002
2	29.5683	29.5713	−.003	+.003
Mean				+.0005

Comparison of Casella no. 3289 (1932) with Casella no. 3306 (1933) at the Geographical Institute: Mean difference of no. 3289 from no. 3306 (10 readings), +0.0063 inch; corrected difference, +0.0043 inch.

Differences of Blue Hill standard from Kew during the period 1885 to 1933: Blue Hill+Kew:

	1885	1887	1892	1893	1933
Barometer no.	2677; 818	818; 872	872; 1019	872; 1019	1019; 3306
Difference, inch	+0.004	−0.001	−0.005	−0.001	−0.0015

Differences of Blue Hill standards from those of Signal Service and Weather Bureau: Weather Bureau−Blue Hill:

1885	1887	1893	1909	1932
Inch	*Inch*	*Inch*	*Inch*	*Inch*
−0.000; −0.004	−0.005	−0.001	−0.003	−0.005

Differences between nos. 872 and 1019; 1019−872:

1893	1909	1932	
		Pressure 28 inches	Pressure 29.3 inches
Inch	*Inch*	*Inch*	*Inch*
−0.001	−0.003	−0.004	−0.006

The original corrections of the barometers under consideration are: No. 818, +0.009 inch; no. 872, −0.001 inch; no. 1019, −0.003 inch; no. 3306, +0.002 inch; the Newman standard, +0.003 inch.

The tube of no. 3306 is so much smaller than those of the other instruments that a longer series of comparisons of this instrument with others will be necessary to determine with satisfactory precision the present-day differences between the various barometers and the Kew normal or primary standard represented by no. 3306; however, the results so far indicate good agreement and the differences are not likely to exceed 0.004 or 0.005 inch (0.08 or 0.10 mm)—an amount ordinarily difficult to detect in current observations.

The comparisons at Blue Hill during the past 48 years indicate variable, slow changes in the largest instrument (Hicks, no. 872), but, since in some instances unusual variability of readings indicates unfavorable conditions for comparisons, it seems likely that the actual differences among these barometers are smaller than they appear to be. During these comparisons the four barometers referred to were cleaned and reconditioned for the first time since they were installed, although, due to the purity of the air at the observatory, the accumulation of oxide, etc., was too small to affect the accuracy of readings. No. 818 was found to contain air, but this, by fortunate chance, was removed by inverting the instru-

ment, which, afterward, was found to have an excellent vacuum and to read apparently as at first; this method of removing air is rarely successful. No. 1019, the errors of which apparently have remained unchanged since it was purchased, appears to be the best of the four barometers and is considered the standard of the observatory.

Director Patterson states that the Newman standard, imported in 1839 and compared with the standard of the Royal Society at Somerset House, originally had a correction of −0.004 inch. Whether the British standard has been changed from that of the Royal Society is not known, but, in any case, the correction, now +0.003 inch, has not changed more than 0.007 inch in 93 years.

The author acknowledges indebtedness to Mr. Arthur Rotch, of Boston, who kindly contributed the expenses of travel incidental to this work, and to the Instrument Division of the Weather Bureau, and to Director Patterson of the Canadian Meteorological Office, for providing necessary facilities and assistance.

At the time the comparisons described herein were completed (early in 1933) no normal or absolute standard was in use in America. Since then two important advances in precision barometry have occurred, of which one is the new primary standard of the National Physical Laboratory, England, and the other the construction of an instrument at the United States Bureau of Standards. News of the latter will be welcomed by American meteorologists who have hoped for the maintenance of an absolute standard of pressure in this country. The new British standard is described in a paper, A New Primary Standard Barometer, by J. E. Sears and J. S. Clark, in the Proceedings of the Royal Society, A, vol. 139, 1933 of which the following summary is quoted:

> The paper contains an account of a new primary standard barometer recently installed at the National Physical Laboratory to serve as a basis of reference for all measurements relating to barometric pressures.
>
> The body of the instrument is constructed in stainless steel, with optically flat parallel glass windows through which the mercury surfaces are observed. These windows can be removed, if necessary, for cleaning, and the vacuum can be restored by means of suitable pumps whenever the instrument is required for use. The average temperature of the mercury column is ascertained by means of a mercurial thermometer with a bulb 30 inches long, immersed in a hole bored in the stainless-steel body parallel to the barometric column.
>
> Two micrometer microscopes are fixed, one above the other, to a massive vertical column which can be translated laterally so as to view either the mercury surfaces, or the divisions of a standard invar scale set up at the side of the barometer body. The height of each mercury surface is taken to be the mean of two microscope readings, one of the direct image of a horizontal cross wire projected into the space above the mercury, and one of the reflection of this image in the mercury.
>
> The design and general accuracy of workmanship are such that individual readings should be correct to the order of 0.001 mm. In practice it is found that the mean residual error of a single observation is of the order of 0.005 mm., this being probably attributable in the main to minute fluctuations of barometric pressure which are continually taking place, even when atmospheric conditions are reasonably steady.

The new instruments of the Bureau of Standards are described briefly in the following extract from a letter recently received from the Director of the Bureau:

> In testing mercurial barometers we are using a Fuess barometer as the standard which had been modified so as to have an all-glass cistern. Special methods of filling the tube have been developed in which the mercury is distilled into the tube while under a high vacuum. We have found that the vacuum above the mercury column when so filled holds for a number of years. This has been checked by intercomparison between 4 Fuess barometers, 3 of which are of the modified type. This intercomparison has usually taken place immediately after the refilling of one of the instruments.
>
> In order to eliminate possible errors due to the loss of vacuum above the mercury column we have recently constructed a mercurial barometer in which the vacuum space above the mercury column is connected to a mercury vapor pump and to a McLeod gage. It is thus possible to both control and measure the degree of vacuum. The scale and vernier from one of the Fuess barometers is used on this instrument which by comparison with the standard meter bar can be relied on to about 0.01 mm. We estimate the over-all accuracy which will be secured with this new arrangement to be ± 0.05 mm. of mercury. This accuracy is better than that of any portable barometer which is likely to be submitted for test.

METEOROLOGICAL CONDITIONS PRECEDING THUNDERSTORMS ON THE NATIONAL FORESTS

1. WESTERN AND CENTRAL OREGON

By W. R. STEVENS

[Weather Bureau, Washington, D. C., November 1934]

The great menace of thunderstorms to forested areas in all the western fire-weather districts of the Weather Bureau has been emphasized many times by all officials connected with the fire-weather work and by forest-protection agencies. In the region under consideration in this paper (western and central Oregon), lightning causes more than one-half of all the forest fires.

It is not apparent to the student of the daily weather map that lightning should be such a great fire-causing factor in this region, because few thunderstorms are observed at first-order Weather Bureau stations in this area. However, at higher elevations in the national forests of western and central Oregon, thunderstorms are frequent, and occasionally so widespread, with so many cloud to ground flashes, that forest-protection agencies are not able to cope with the situation unless they are warned at least a few hours in advance.

It is the purpose of this paper to discuss thunderstorms, particularly in relation to the national forests of western and central Oregon, and to present an analysis of the meteorological conditions that ordinarily precede their occurrence in that region.

CAUSES OF THUNDERSTORMS

The thunderstorm is the result of vigorous vertical convection of humid air. The thunder and lightning which attend the storm play no part in its mechanism.

When vertical convection of air occurs, the air is said to be unstable. Instability may be brought about by strong surface heating; by overrunning of one layer of air by another at a considerably lower temperature; by underrunning and uplift of a saturated layer of air by a denser layer; and by forced ascent of humid air masses up mountain slopes.

There are two classes of thunderstorms, (1) the heat thunderstorm, and (2) the cyclonic thunderstorm. This classification is based upon the cause of the instability which produces the storms. There are other classifications of thunderstorms, but this one suits best for the present discussion.

Conditions are favorable for the genesis of heat thunderstorms when the pressure is nearly uniform and slightly below normal over a wide area. When this situation prevails, the winds are light and the surface air becomes

strongly heated, resulting in vigorous vertical convection currents and cumulo-nimbus clouds, provided the decrease of temperature with altitude (lapse rate) exceeds the dry adiabatic rate of 1° C. per 100 meters, and sufficient water vapor is present to produce raindrops in the rising air. Genesis of heat thunderstorms is favored by drafts up the sides of mountain ranges, mountain peaks, and valleys. Storms of this type are very likely to form after 2 or 3 days of unusually warm weather, when the lower air has become so heated that convection extends to high altitudes.

Cyclonic thunderstorms may occur in the southeast quadrant of a cyclone, in which case the high lapse rate necessary for rapid convection results from the different directions of the lower and upper air currents. The surface air in the southeast quadrant flows from warmer regions, while the currents aloft, which flow more nearly from the west, are often sufficiently colder to induce the convection necessary to the production of thunderstorms.

Cyclonic thunderstorms also occur along the "cold front" of a cyclone. Warm tropical winds are associated with the eastern portion of a cyclone, while cold polar winds prevail over the western portion. The boundary between these two systems of winds is usually well marked, and is known as a "cold front." The cold air advances in the form of a wedge. Friction at the surface of the earth retards the advance of the cold air, while the cold air aloft advances unimpeded. This results in a wedge with its point some distance above the ground. Beneath the overhanging front of cold air, warm air is entrapped, which results in strong convection, either through the overrunning cold air or out in front of it, and the squally winds that are always associated with the passage of a cold front.

That thunderstorms do not occur at times when the pressure distribution appears favorable for their inception is due to certain factors that are not apparent from surface observations. For instance, the lapse rate may not be high enough to permit strong convection currents, or there may not be sufficient water vapor present to cause condensation within the limits of the vertical currents that do form.

In this study, moisture conditions at the surface, as indicated by the vapor pressure, are used in the discussion of thunderstorm forecasting. It is true that temperature and moisture conditions aloft are as important, or more so, as those at the surface in producing thunderstorms, but observations of these are not available for the region under consideration.

PRECIPITATION IN THUNDERSTORMS

Rain does not fall continuously during a thunderstorm, (in fact, none may fall), but generally in very heavy showers. Everyone is familiar with the fact that rain after almost ceasing may begin again with great violence after a lightning flash.

Condensation occurs in the ascending current as soon as the temperature of the rising air is reduced to the dew-point. The raindrops do not fall immediately, but are carried upward. Small raindrops fall very slowly through still air, and can be carried upward by a relatively slow ascending current. Lenard[1] has shown that raindrops cannot fall through air of normal density whose upward velocity is greater than 8 meters per second, nor fall themselves with greater velocity through still air. When raindrops form larger than 5 or 6 millimeters in diameter, they are unstable, and immediately break up into smaller drops.

The ascending current in a thunderstorm is not steady, so that the raindrops intermittently rise and fall, alternately breaking up into smaller drops and coalescing into larger ones. The drops which get to the edge of the ascending current, or reach the top of the current and spread out horizontally, fall to the ground, and produce the heavy rain during the early part of the storm.

The occasional occurrence of hail in thunderstorms is definite proof that ascending currents frequently are very violent and extend to high altitudes. The raindrops are carried upward into the region of freezing temperature, where they congeal and obtain a coating of snow. After a time, during a lull in the ascending current, they fall to the region of liquid drops where they gather a layer of water, part of which is frozen by the low temperature of the kernels. Thus, a hailstone which makes a number of journeys from the rain level to the snow level alternately receives a covering of ice and snow. The sizes of the hailstones are roughly proportional to the strength of the ascending currents. However, since the weights of the stones vary approximately as the cubes of their diameters, while the supporting force of the current varies approximately as the square of the diameters of the hailstones, a limiting size is quickly reached.

Humphreys[2] states that experiment shows that the vertical velocity necessary to sustain a hailstone 1 inch in diameter is at least 59 miles per hour, and 116 miles per hour if the stone is 3 inches in diameter.

Formation of raindrops is essential to the occurrence of lightning. However, it is a common occurrence in semiarid regions, and less frequently in other sections, to see lightning but no rain reaching the ground. The reason for this phenomenon is that the lower air is so dry that the drops are evaporated before they reach the earth's surface.

INSTABILITY IN NATIONAL FORESTS OF WESTERN AND CENTRAL OREGON

The convective processes which produce the majority of thunderstorms in the national forests of western and central Oregon are induced by strong surface heating in connection with a trough of low pressure which extends in a general north-south direction from British Columbia to northwestern Mexico. The convection is aided by drafts up the mountain slopes, and probably at times by overrunning of relatively cool air currents.

Occurrence of the cyclonic type of thunderstorm in this region is very rare.

DATA

The thunderstorm observations used in this study (1925–31, inclusive) were very kindly furnished by Dr. Thornton T. Munger, Director of the Pacific Northwest Forest Experiment Station at Portland, Oreg. These data have been made the subject of an article by William G. Morris of that station entitled "Lightning Storms and Fires on the National Forests of Oregon and Washington." A summary of Mr. Morris' paper immediately follows this article on page 370.

TYPES OF THUNDERSTORM DAYS

Three types of thunderstorm days have been defined by Mr. Morris. The "local" storm day is one on which one or a few storms occur that affect only a small area

[1] Lenard, P., Met. Zeit., 21; 249, 1904.

[2] Humphreys, W. J., Physics of the Air, second edition, p. 346.

of the region. The "general" type either has many small storms which affect two-thirds of the area, or has one or more storms which make a continuous track at least two-thirds the length of the region. The "intermediate" storm day is one on which the storms are more widespread than on the "local" day, but less extensive than on the "general" day.

In this paper, the terms "intermediate" and "general" are replaced by "scattered" and "wide-spread", respectively, because they correspond better with forecast terminology.

A "local" storm day causes only one forest fire, on the average. Fires started on this type of day are, as a rule, quickly controlled and suppressed without any extra preparations being made. For this reason, when it is obvious from the weather map or relationships given in this paper that if any thunderstorms occur at all they will be sufficient to produce only a "local" storm day, a forecast of thunderstorms should include a modifying term, such as "local", to indicate to forestry officials that meteorological conditions are not menacing, but that a few storms are likely to develop. Modifying terms such as "scattered" and "wide-spread" would indicate that storms of a more dangerous type, and to a degree defined by the respective terms, are likely to develop.

SEASON OF LIGHTNING FIRE HAZARD

The season of lightning fire hazard begins in western and central Oregon in June and ends in September, as a rule.

The following table shows the number of thunderstorm days on the national forests of this area from June to September, inclusive, classified with respect to type, for the 7 years studied.

	Local	Scattered	Wide-spread	Total
June	32	5	1	38
July	43	16	13	72
August	43	13	10	66
September	32	13	5	50

The season included in this study is the months of July and August, as the above figures indicate that the thunderstorm situation is most acute during this period.

RELATIONSHIPS

A number of relationships between various meteorological elements and the occurrence of thunderstorms will be presented in this paper and in succeeding articles treating of other national forests. It is emphasized that these relationships are intended as adjuncts to the daily weather maps. It is not presumed that better forecasts can be made from these relationships alone than those that an experienced forecaster can make who is familiar with meteorological conditions that ordinarily produce thunderstorms in the region. However, it is believed that they are valuable aids in thunderstorm forecasting, because they indicate when conditions are relatively safe, that is, if thunderstorms develop at all the probability is great that there will be only a sufficient number to produce a "local" storm day; and when conditions are likely to be dangerous.

It must be borne in mind that only a 7-year period is included in this study, and therefore the conclusions reached necessarily are provisional.

Use of barometric pressure reduced to sea level as one of the factors is obvious, as it has been known for a long time that there is a relation between pressure distribution and thunderstorm activity.

Pressure differences between various stations are used as an indication of the north-south trough of low pressure mentioned above, or the presence of a cyclonic disturbance to the north of the region.

Vapor pressure also is used to indicate whether moisture conditions are favorable for thunderstorm inception.

METEOROLOGICAL CONDITIONS IN MORNING AND THUNDERSTORM ACTIVITY SAME DAY

When the thunderstorm reports were plotted against the 8 a. m. E. S. T. pressure at Seattle, a rather definite line of demarcation at 30.05 inches was revealed. When the pressure was above this figure, those thunderstorms that occurred the same afternoon and evening were usually only sufficient to produce a "local" storm day. During the seven July months studied, only three "wide-spread" and four "scattered" storm days occurred when the morning pressure at Seattle was above 30.05 inches, as was the case on 53 percent of the days. Four "wide-spread" and two "scattered" storm days occurred during the August months under this condition, which prevailed on 50 percent of the days. On the other hand, when the pressure was below 30.05 inches, the storms were more frequent and more dangerous.

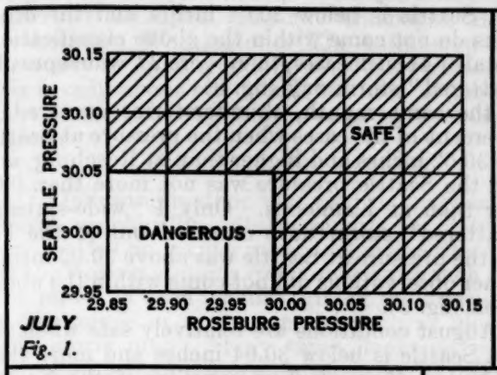
On all "scattered" and "wide-spread" storm days that occurred with pressure above 30.05 inches at Seattle, the morning pressure at Roseburg was below 30.10 inches during July, and below 30.12 inches in August.

No "wide-spread" storm days occurred during July when the Seattle pressure was below 30.05 inches and the Roseburg pressure higher than 29.98 inches. Three "scattered" storm days occurred under these circumstances out of a total of 44 days. Here again we find a very sharp line of demarcation. Whenever the pressure in the morning is below 30.05 inches at Seattle in July and lower than 30 inches at Roseburg, the day must be regarded as potentially dangerous, especially if other meteorological conditions indicate that thunderstorms are probable (fig. 1).

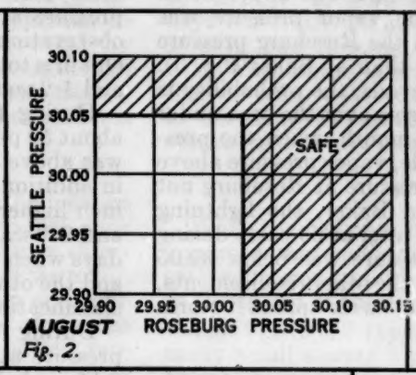
When the Seattle pressure is below 30.05 inches and the Roseburg pressure higher than 30.02 inches in August, the day is relatively safe (fig. 2). Not a single "scattered" or "wide-spread" storm day occurred under these conditions out of a total of 23 days.

Another important factor in thunderstorm activity which is apparent in August, but shows up to only a small extent in July is the 24-hour pressure change at Portland. Any day in August that the pressure is below 30.05 inches at Seattle, below 30.04 inches at Roseburg, and the pressure at Portland has fallen 0.04 inch or more in 24 hours must be regarded as dangerous (fig. 3).

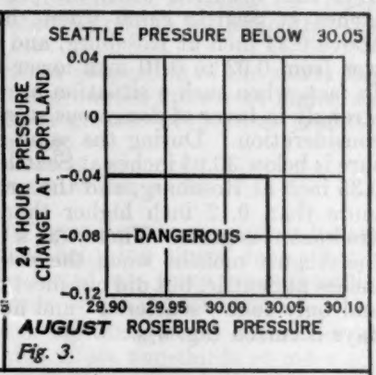
During the July months, it was found that when the pressure is below 30.05 inches at Seattle, the vapor pressure above 0.35 inch at Roseburg, and in addition the pressure at Roseburg is not more than 0.08 inch higher than at Baker, a dangerous situation exists. Under these circumstances many thunderstorm days of the "scattered" and "wide-spread" types occur. However, any day that the Seattle pressure is below 30.05 inches and does not meet the other requirements is relatively safe (fig. 4). Out of a total of 50 such cases, there was only 1 "wide-spread" and 1 "scattered" storm day. When the pressure is above 30.05 inches at Seattle, the vapor pressure at Roseburg and the pressure difference between Roseburg and Baker seem to have little significance. During August, however, all the "wide-spread" and "scattered" storm



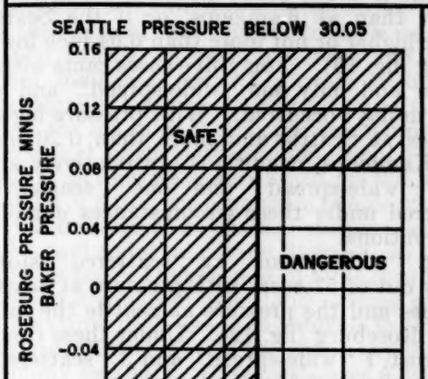
JULY
Fig. 1.



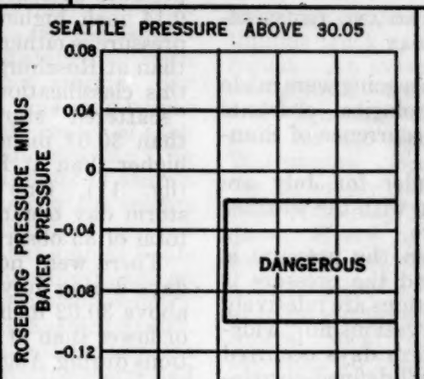
AUGUST
Fig. 2.



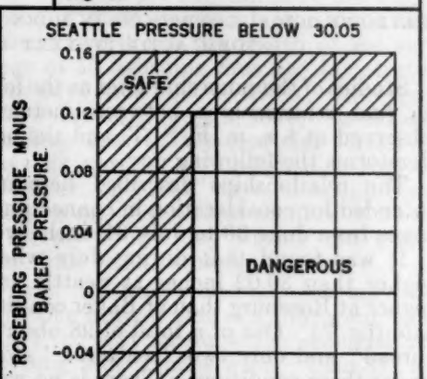
AUGUST
Fig. 3.



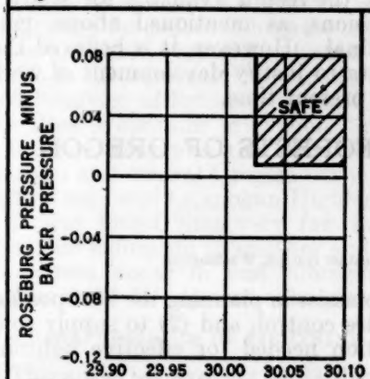
JULY
Fig. 4.



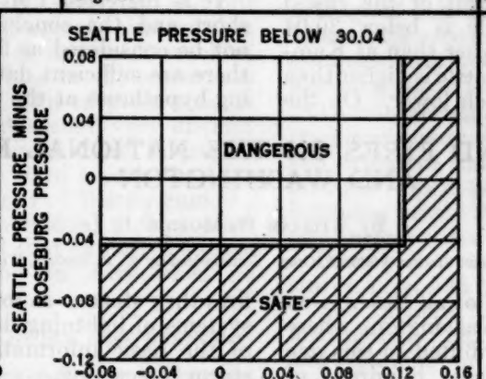
AUGUST
Fig. 5.



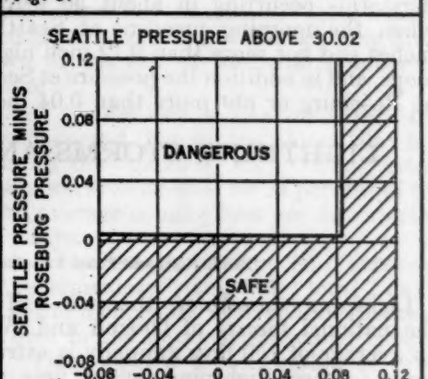
AUGUST
Fig. 6.



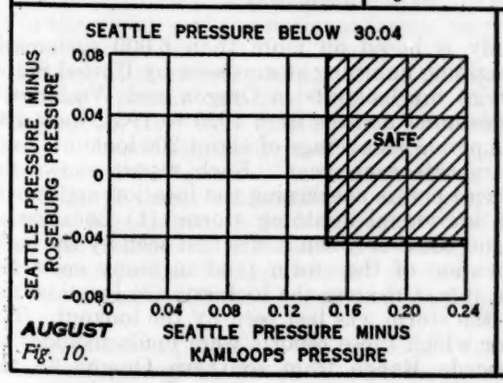
JULY
Fig. 7.



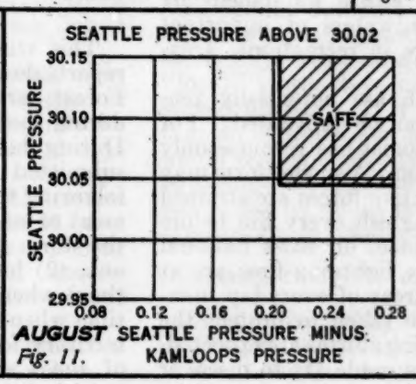
JULY
Fig. 8.



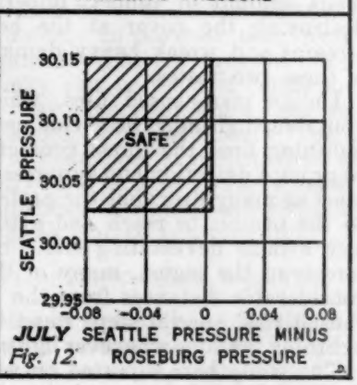
JULY
Fig. 9.



AUGUST
Fig. 10.



AUGUST
Fig. 11.



JULY
Fig. 12.

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days that occurred when the pressure was above 30.05 inches at Seattle came when the vapor pressure was above 0.34 inch at Roseburg, and the Roseburg pressure was from 0.02 to 0.10 inch lower than at Baker (fig. 5). In fact, when such a situation prevails, the probability is strongly in favor of dangerous storms over the area under consideration. During the same month, when the pressure is below 30.05 inches at Seattle, vapor pressure above 0.35 inch at Roseburg, and the pressure at Roseburg not more than 0.12 inch higher than Baker, the lightning fire hazard is great. There was a total of 53 cases during the August months when the pressure was below 30.05 inches at Seattle, but did not meet the other requirements, and only four "scattered" and no "wide-spread" storm days occurred (fig. 6).

METEOROLOGICAL CONDITIONS IN MORNING AND THUNDERSTORM ACTIVITY NEXT DAY

Studies of the same character as the foregoing were made to find relationships between meteorological elements observed at 8 a. m. E. S. T. and the occurrence of thunderstorms the following day.

The relationships described hereunder for July are intended for consideration in connection with the weather maps from June 30 to July 31, inclusive.

It was found that during July when the pressure is higher than 30.02 inches at Seattle and the pressure is higher at Roseburg than at Baker conditions are relatively safe (fig. 7). Out of a total of 98 observations no "wide-spread" and only two "scattered" storm days occurred under these conditions. There is no well defined correlation between these factors and the occurrence of thunderstorms during August.

During July conditions are relatively dangerous (thunderstorms occurring in about 50 percent of the cases) when the morning pressure at Seattle is below 30.04 inches and not more than 0.12 inch higher than at Kamloops, and in addition the pressure at Seattle is higher than at Roseburg or not more than 0.04 inch lower. On the other hand relatively safe conditions prevail when the pressure at Seattle is below 30.04 inches and the other observations do not come within the above classification. Out of a total of 41 such cases, there were 2 "wide-spread" and 1 "scattered" storm day (fig. 8).

During the same month, thunderstorms occurred in about 50 percent of the cases when the pressure at Seattle was above 30.02 inches and higher than at Roseburg, and in addition the Seattle pressure was not more than 0.08 inch higher than at Kamloops. Only 1 "wide-spread" and 3 "scattered" storm days occurred out of the 119 days when the pressure at Seattle was above 30.02 inches, and the other observations did not come within the above classification (fig. 9).

During August conditions are relatively safe when the pressure at Seattle is below 30.04 inches and more than 0.14 inch higher than at Kamloops, or if the Seattle pressure is either higher or not more than 0.04 inch lower than at Roseburg (fig. 10). Forty-five cases came within this classification and only one "wide-spread" and no "scattered" storm days occurred. With pressure higher than 30.02 inches at Seattle and more than 0.20 inch higher than at Kamloops, conditions are relatively safe (fig. 11). One "wide-spread" and one "scattered" storm day occurred under these circumstances out of a total of 35 observations.

There were no "wide-spread" or "scattered" storm days during July out of 57 cases with pressure at Seattle above 30.02 inches and the pressure at Seattle the same or lower than at Roseburg (fig. 12). Under these conditions during August, 1 "wide-spread" and 3 "scattered" storm days occurred out of 47 cases.

CONCLUSION

It is regretted that the record available for study is short and the conclusions, as mentioned above, must not be considered as final. However, it is believed that there are sufficient data to justify development of working hypotheses at the present time.

LIGHTNING STORMS AND FIRES ON THE NATIONAL FORESTS OF OREGON AND WASHINGTON

By WILLIAM G. MORRIS

[Pacific Northwest Forest Experiment Station, Portland, Oreg. Summarized by W. R. Stevens, Weather Bureau, Washington]

Lightning causes more than one-half of all the fires on the national forests of Oregon and Washington, where an average of 750 fires annually is attributed to this one cause. These lightning-caused fires cost hundreds of thousands of dollars to extinguish; they destroy an enormous amount of timber, imperil entire watersheds by destroying the cover at the headwaters of important streams and wreak heavy damage in recreational areas of these two States.

Unlike man-caused fires, which are potentially preventable, lightning fires can never be prevented. For lightning fires, the forest protectionist has recourse only to prompt detection and suppression. A single storm may start so many fires that the protective forces are strained to the utmost to reach and extinguish every fire before any attains devastating size. Since, on most national forests of the region, many of the lightning fires are at considerable distances from the areas of everyday man-caused risk, special steps must be taken to protect the lightning fire zone whenever lightning storms are expected.

The study here reported on was made (1) to discover the fundamental characteristics of lightning storms and the fires they start so as to assist in planning the best possible systems of lightning fire control, and (2) to supply some of the basic information needed for effective lightning storm forecasting.

BASIC DATA

This study is based on more than 6,000 systematic reports describing lightning storms seen by United States Forest Service fire lookouts in Oregon and Washington during the summer months from 1925 to 1931, inclusive. During this period an average of about 200 lookouts have submitted reports each year. Each report shows the following three points concerning the location and movement of an individual lightning storm: (1) Location of the storm and the time when it was first seen by the lookout; (2) location of the storm (and in many cases the time) when it was nearest the lookout; (3) location and time when the storm was last seen by the lookout. The territory for which these reports were made includes all of the Cascade Range from southern Oregon to the British Columbia boundary, the Coast Range in western

Oregon, the Blue Mountains in eastern Oregon and southeastern Washington, and the Okanogan Highlands in northeastern Washington. The total area covered by the study is approximately 25,000,000 acres. Although this is only about one-fourth the area of the two States, most of the lightning storms occur in these mountainous regions.

MAPPING THE REPORTS

The following method was used to analyze the lookout reports graphically. Storm reports for individual days were plotted on tracing paper laid over a State map showing the lookout stations (scale one-eighth inch to the mile). The report of each lookout, giving the location and time of occurrence of a lightning storm was plotted on the daily storm map. Many times, lookouts reported separate storms in progress simultaneously at different points on the horizon. Such plotted reports were treated as individual storms whenever the time and distance between them indicated that they were distinct storms. By graphically sorting all plotted reports and combining those for the same storm, the approximate center of each individual storm path was determined and drawn. The census, in this way, was based on the number of storms instead of either the number of people who saw the storms or the number of days when storms occurred.

From the plotted reports, it was plain that a single lightning storm in Oregon and Washington usually is not an isolated cumulo-nimbus cloud moving across the country in a narrow path like many storms in the Eastern States. Instead, it often covers the entire sky from the viewpoint of many lookouts. In several cases a lightning storm had a path 40 miles wide.

SUBREGIONS

Mapping of storm occurrence and movement had not progressed far before it became increasingly evident that there are three very distinct areas in the region, each of which is distinguished by peculiarities in the occurrence and behavior of lightning storms. One of these areas is the Blue Mountains in Oregon. A second very distinct subregion comprises the remaining national forests in western and central Oregon. The third area is the Cascade Range and Okanogan Highlands of Washington.

It was found that very few individual storms cross from one subregion to another and that extensive storms sometimes occur in one subregion on days when no storms occur in adjacent subregions.

CHARACTERISTICS OF LIGHTNING STORM OCCURRENCE

There was an average of 23 days per year in western and central Oregon, 25 days in Washington, and 27 days in the Blue Mountains when lightning storms occurred on or in the vicinity of the national forests between July 1 and September 10.

In spite of there being 63 days from 1925 to 1931 when "general" storms occurred somewhere in Oregon or Washington, there were only 4 days when the storms were "general" simultaneously in all subregions, and 13 days when they were "general" in two subregions at the same time. In 16 cases "intermediate" and "general" storms occurred simultaneously in 3 subregions, and in 38 cases they occurred at the same time in 2 subregions. During the 7-year period, "intermediate" or "general" storms developed somewhere in Oregon and Washington on 149 days.

Twenty-seven percent of the "general" days produced individual storms in the early morning (4 a. m. to 10 a. m.), and 28 percent produced storms at night (10 p. m. to 4 a. m.). In contrast, occurrence of storms on "local" days was restricted almost entirely to the period between 10 a. m. and 10 p. m.

In Washington, a greater proportion of the storm days than in other subregions produced storms at night, and in the Blue Mountains a greater proportion produced storms in the early morning.

TYPES OF STORM DAYS

While the daily storm maps were being made it became apparent that individual lightning storm days affecting each subregion could be sorted into three types according to the extent of the storms within the subregion.

The "general" type of lightning storm day either has many small storms which affect two-thirds or more of a subregion, or has one or more storms which make a continuous track at least two-thirds the length of the subregion. An average of 35 lightning fires per day started on "general" storm days from 1925 to 1931. One "general" lightning storm day on August 2, 1929, was responsible for 215 lightning fires in the national forests of Washington. Sixty-six percent of all lightning fires in the region are started on "general" days, although these days form only 16 percent of the total number of storm days. Every "general" storm day during the period resulted in lightning fires on the national forests.

The "local" type of lightning storm day has only one or a few storms affecting a small area of a subregion. On several "local" days the only storm which occurred was less than 15 miles long and 5 miles wide. Usually, the "local" storms were from 15 to 60 miles long and about 5 miles or more in width. When no more than 4 or 5 such storms occurred and they were restricted to 1 part of a subregion the day was classified as "local." An average of only one fire per day started on "local" days. These days accounted for 10 percent of the lightning fires, although they form 59 percent of the total number of lightning storm days.

An "intermediate" storm day is one on which the storms are more wide-spread than on the "local" day but less extensive than on the "general" day. The "intermediate" storm days were responsible for 24 percent of the lightning fires. An average of nine fires per day started on "intermediate" days.

During the period studied there were 86 "general" storm days, 135 "intermediate", and 307 "local" days.

The "general" storm days cause nearly all of the peak load of lightning fires in the national forests of Oregon and Washington. They yield a great number of fires, and the fires come all at once. There may be 30 lightning fires set within 2 or 3 hours on a single national forest. This sudden outbreak of fires taxes the forest protective forces to their physical limits. In contrast the "local" storm days cause no overload. The few fires started on "local" storm days usually can be reached before they spread greatly. If a forest supervisor knew definitely that an expected storm would be of the "local" type, it would not be necessary to make special preparations for lightning-fire suppression, but, if he expected a "general" storm day he would be justified in making extraordinary preparation to handle a peak load of lightning fires.

CHARACTERISTICS OF LIGHTNING-STORM BEHAVIOR

Most individual lightning storms on the national forests of Oregon and Washington affected an area 11 to 60 miles in length, or appeared to move through that distance. Only a few storms have exceeded 80 miles in

length, yet one storm in Washington is definitely known to have been at least 280 miles long.

The speed of individual lightning storms in the region was usually from 6 to 20 miles per hour. Very few storms moved faster than 40 miles per hour.

Lightning-storm movement was most often toward some northerly direction. In the Blue Mountains many more storms move toward the northeast than any other direction. Between 10 and 20 percent move toward each of the following directions: North, east, and southeast. Less than 5 percent move toward any one direction between south and northwest, inclusive. In western and central Oregon the most frequent directions of movement are north and northeast, each direction having nearly an equal number. Nearly 20 percent of the storms in this section move toward the northwest. The Washington storms are even less consistent in their direction of movement. For example, 56 per cent of them are about evenly divided between north, northeast, and southeast and 35 percent between south, east, and northwest.

The uniform direction of movement in certain subregions may be of some aid in obtaining warning of storms already in progress. Forests in the Blue Mountains can expect about 80 percent of their lightning storms to approach from the southward, and look-outs can warn fire-control forces to the northward. An estimate of the hour when a storm will reach a certain locality can be obtained by plotting and timing its movement during the early part of its course. If a lightning storm is seen forming, there are 60 chances in 100 that it will move forward at least 20 miles before dissipating. If a storm is 15 miles distant when first observed, there are about 80 chances in 100 that it will not arrive within 45 minutes.

The percentage of lightning flashes which occur between one cloud and another has been considered an important characteristic which may distinguish fire-causing from non-fire-causing lightning storms. The observations made by United States Forest Service look-outs include the total number of lightning flashes seen and an estimate of the percentage of these flashes which were confined to the clouds.

The observations indicate that lightning storms in the mountains of Washington and Oregon are most frequently the type having a large percentage of cloud-to-cloud flashes. The percentage of look-out reports indicating various proportions of cloud-to-cloud flashes is as follows:

Cloud-to-cloud flashes (percent):	*Percentage of 4,800 observations*
0 to 25	24
26 to 50	18
51 to 75	18
76 to 100	40

The percentage of cloud-to-cloud flashes was greater when more than 10 flashes were seen than when less than 10 were observed by the lookout.

There is little difference between the percentages of cloud-to-cloud flashes in day and night lightning storms. Likewise, there is no significant difference between the percentages of cloud-to-cloud flashes in different years. "Local" storm days have a greater percentage of cloud-to cloud flashes than the "general" days. This may account partly for the greater number of lightning fires started on "general" storm days.

LIGHTNING STORM PATHS AND "BREEDING" SPOTS

It has been suggested many times that there may be lanes formed by valleys or ridges, which lightning storms follow consistently. A careful study of seven yearly composite maps of storm paths (fig. 1) shows that there are no such narrow routes of travel for storms in the national forests of Oregon and Washington.

The existence of lightning storm "breeding" spots has been mentioned by several writers and by many casual observers. These spots are conceived as being valleys, mountain peaks, etc., over which lightning storms form time after time. If such "breeding" spots exist, and if their locations were known, they could be watched closely in order to obtain advance warning of developing lightning storms. In order to locate any such "breeding" spots, starting points of the 2,600 individual storms reported during the 7 years were located on one map. This map indicated that such definite spots do not exist in the region studied.

Each series of consecutive storm days in a single subregion was studied to learn whether it is common for a certain type of storm day to be a forerunner of other storm days.

It was found that between July 1 and September 10, whenever there had been no "intermediate" or "general" storms for 2 or more days in the Blue Mountains, the occurrence of an "intermediate" storm day was followed in 46 percent of the cases by either another "intermediate" or a "general" storm day in that subregion. In Washington 39 percent and in western and central Oregon 42 percent of the "intermediate" storm days were followed by other "intermediate" or "general" storm days in those subregions.

LIGHTNING STORM ZONES

A map showing zones of relative lightning storm frequency was constructed from the daily charts of individual storm paths (fig. 2). A comparison of these zones with the topographic map suggests a close relationship between storm frequency, the mountains, and the hot summer climate east of the Cascade Range. The boundaries of lesser storm frequency conform especially well with the outlines of the foothills. The zones of greatest frequency are east of the Cascade Range in mountainous areas. The study shows that certain national forests have twice as many storms as those adjoining. Furthermore, certain parts of a forest may have twice as many storms as other parts of the same forest.

LIGHTNING FIRE KINDLING MATERIALS

A knowledge of the relative number of lightning fires ignited in each type of forest material is necessary in estimating lightning fire danger from the standpoint of inflammability of fuels. If the fuels which most frequently kindle lightning fires are very wet due to recent rains, the chance of ignition by a lightning strike will be small, but, if these fuels are dry, there is a great chance that lightning fires will be started.

The number of lightning fires ignited in each fuel material at each altitude on each national forest from 1925 to 1930, inclusive, was determined from the systematic Forest Service reports which describe the circumstances concerning every fire within the national forests. Needles and duff on the ground formed the most important kindling material. Live trees were second in importance and dead trees were third. In several national forests on the west slope of the Cascades, however, dead trees kindled more fires than any other material. Grass was important only in northeastern Washington.

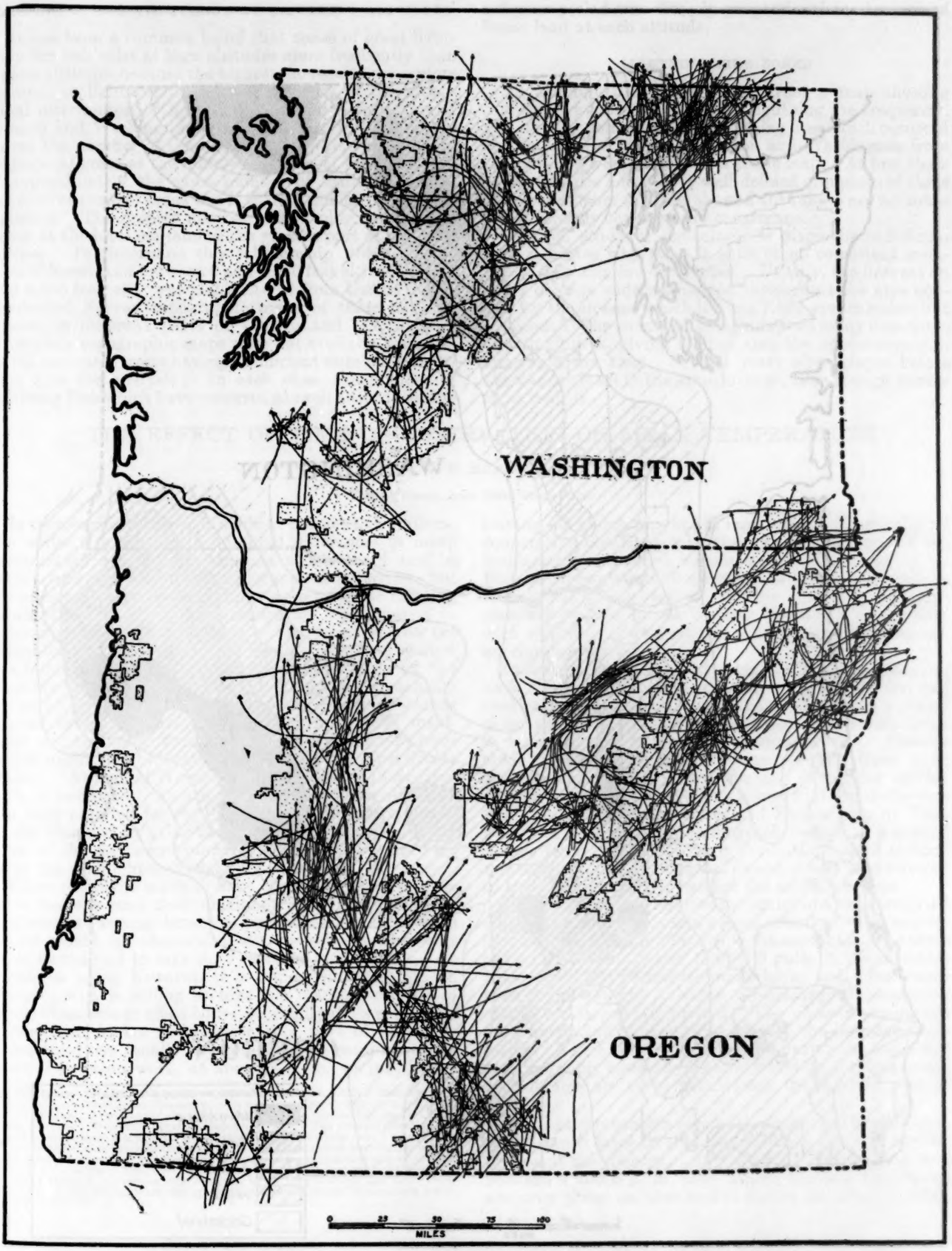


FIGURE 1.—Paths of all lightning storms reported by national forest fire lookouts in Oregon and Washington during 1930.

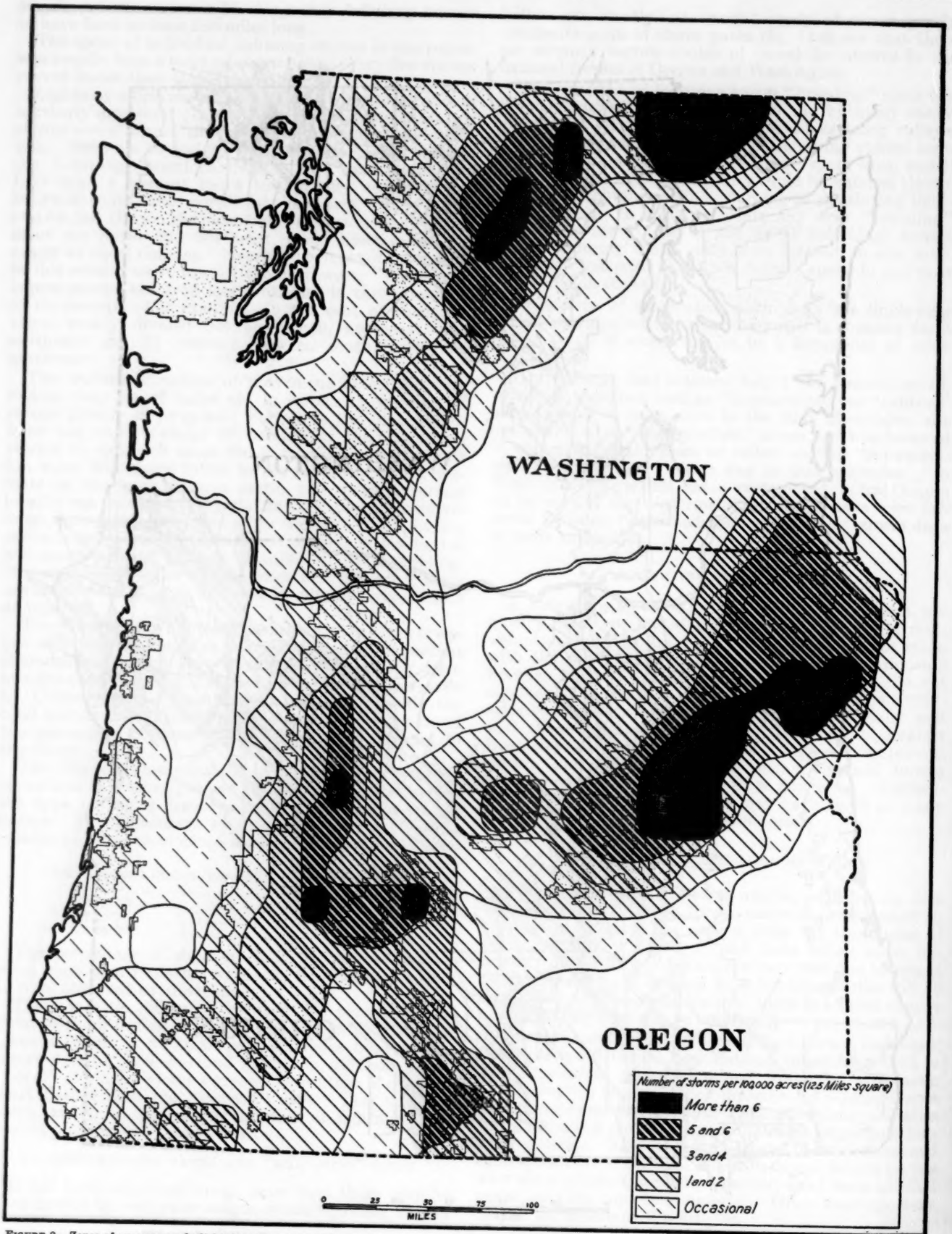


FIGURE 2.—Zones of average yearly lightning-storm distribution in the vicinity of the national forests of Oregon and Washington as determined by more than 2,600 storm paths charted from national forest fire lookout reports during the 7-year period, 1925–31, inclusive.

LIGHTNING FIRE FREQUENCY AT DIFFERENT ALTITUDES

It has been a common belief that zones of great lightning fire risk exist at high altitudes more frequently than at low altitudes because the highest mountains seem more exposed to lightning flashes; but analysis of the altitudinal distribution of lightning fires in the mountains of Oregon and Washington shows that on a given national forest the number of lightning fires per acre at low altitudes is as great as the number per acre at high altitudes if approximately the same number of lightning storms occur over the two areas and if there is sufficient kindling material. The greater number of lightning fires simply occur at the level containing the greater part of the land surface. To determine this relationship precisely, the area of forest land between 0 and 2,000 feet altitude, 2,000 and 4,000 feet, etc., was planimetered from United States Geological Survey topographic maps of three national forests in different parts of Oregon and Washington. (Complete topographic maps were not available for additional national forests having a sufficient number of lightning fires for analysis.) In each case, the number of lightning fires which have occurred at each altitude during a 6-year period was directly proportional to the area of forest land at each altitude.

LIGHTNING FIRE ZONES

An attempt was made to construct a map showing comparative horizontal zones of lightning fire frequency. The starting points for 5,500 lightning fires which occurred on the national forests of Oregon and Washington from 1925 to 1931 were plotted on a single map. At first there appeared to be a few fairly well-defined groupings of these fires, but further analysis showed that there are no zones of consistently repeated fire occurrence.

Detailed study of lightning fire maps for individual days indicates why there is little or no consistent zonation of lightning fire occurrence. Usually, the fires set on any 1 day are widely scattered throughout the area covered by the storms, which is often 7,500 square miles; but occasionally the storms of a single day set many fires within a small area, giving to that area the appearance of a dangerous fire zone. Several years often elapse before another fire is set in the same locality, even though storms occur over it.

THE EFFECT OF TIME OF OBSERVATION ON MEAN TEMPERATURE[1]

By W. F. RUMBAUGH

[Weather Bureau, Boise, Idaho, October 1934]

In meteorological records made at cooperative stations, the writer has frequently observed differences in mean temperature at adjacent stations which could not be satisfactorily explained by topographical influences, but the observations at these stations were taken at differing times of the day, so this investigation was pursued to determine what effect the *time of observation* has on the computed mean temperature. For the benefit of readers not familiar with the climatological work done by the Weather Bureau, it may be stated that mean monthly temperatures at all stations, whether regular Weather Bureau or cooperative, are computed from daily maximum and minimum temperatures for a definite 24-hour period ending at the same time each day for a particular station. At regular Weather Bureau stations, this period ends at midnight. As a midnight-to-midnight standard has been adopted for regular Weather Bureau stations, means obtained by using 24-hour periods ending at other times of the day were compared with those obtained by using the midnight-to-midnight basis.

Effort usually is made to have the observers at cooperative stations read their maximum and minimum thermometers at as near sunset as practicable. Comparable values would be obtained if all cooperative observers could be induced to take their readings at that hour. In numerous cases, however, it is impossible to obtain an observer who is willing to take the readings outside of regular business or office hours, especially if his employers require him to act as observer as a part of his work. These observers usually desire to take the readings either when they begin work, at about 8 a. m., or just before leaving, at about 5 p. m., in most cases. Practically all cooperative observers take their readings at one of the hours mentioned above, namely, sunset, 8 a. m., or 5 p. m. For this reason, means from extremes for 24-hour periods ending with these hours, together with the midnight standard adopted by the Weather Bureau for comparison with records made at regular Weather Bureau stations, are compared in this study.

In order to pursue this investigation, it was necessary to have four sets of thermometers in a ground shelter, and read each set at one of the times named above for a period of several years; or to obtain thermograph records made in a ground shelter for a like period of time. Records made in a roof shelter are not comparable with those made in a ground shelter, hence the use of regular station records was precluded. When, however, it was discovered that the United States Bureau of Entomology at Twin Falls had been making thermograph records in a ground shelter for a period of over 6 years, the second method was adopted, and the original record sheets here referred to borrowed in order to extract the necessary data.

Twin Falls is situated near the center of a large irrigated tract, surrounded by mostly level country. The nearest mountains are about 20 miles to the southeast. As there are no mountains nearer than 100 miles in the direction from which the prevailing winds blow, and none nearer than 20 miles in any direction, air-drainage and inversion effects are largely eliminated. The climatic conditions are representative of a large part of the intermountain region. There usually is little wind during the night and early morning, especially if the sky is clear, but frequently considerable air movement during the warmer part of the day.

In the intermountain region, the maximum temperature occurs much later in the afternoon than in the moister regions of the country. At Twin Falls, it usually occurs between 4 and 6 p. m. from March through September, and only about an hour earlier during the other months,

[1] This study of the effect of time of observation on the *mean* monthly temperature as determined from the daily maxima and minima may be compared with the investigation by E. S. Nichols, of the effect of time of observation on the minima and maxima themselves, MONTHLY WEATHER REVIEW, September 1934. The primary question considered in these papers is that of the *comparability* of records; on the closely related problem of the discrepancy between temperature means as determined by different conventional observing procedures and the true mathematical mean, reference may be made to: Hartzell, Comparison of Methods for Computing Daily Mean Temperatures, MONTHLY WEATHER REVIEW, November 1919; McAdie, Mean Temperatures and their Corrections in the United States, Washington, 1891; Hann, Lehrbuch der Meteorologie, 4 aufl., pp. 93-96.—EDITOR.

and the temperature usually does not fall appreciably during the first hour or two after that time. Minimum temperatures generally occur at sunrise or a few minutes afterward, and on clear mornings a rapid rise begins about half an hour after that time.

With the thermograph record-sheets for the entire 6¼ years available, daily maximum and minimum temperatures were extracted for 24-hour periods ending at the four times mentioned above, and monthly means were computed from these data. The maxima obtained for the period ending at 8 a. m. were in all cases charged to the preceding day. These extremes were considered to be observation readings of maximum and minimum thermometers made at these times. No instrumental corrections were applied, as instrumental error would have the same effect on all values, and therefore not affect the differences. The rapid rise in temperature, which on clear mornings begins about half an hour after sunrise, made an excellent time check, as practically all sheets showed at least two or three such mornings, and most of them more than that. Most of the time, however, the thermograph was found to be running on time, or very close to it. After the monthly means were computed, means for all months of the same name and time of observation were computed, and then the differences between the mean obtained by observations taken at each of the three times during the day and the midnight standard. As sunset occurs close to 5 p. m. during the months of November, December, and January, the 5-p. m. values were used for sunset also during these months.

Table 1 shows the variation in mean temperature from the midnight-to-midnight standard produced by taking the observations at the other three times named above. All available data were used in its preparation, and it is believed that if longer records had been available, the results would not have been materially different.

Because the maximum temperature occurs so late in the afternoon in Idaho, observers who take their readings at 5 p. m., do so at approximately the same time that the maximum occurs during 7 months of the year; and during the other 5 months, the temperature has fallen only a little from the maximum by that hour. Therefore 1 warm day would result in 2 high maximum readings, one on the warm day, and the other on the next; while 1 cold night would result in only 1 low minimum reading being recorded. The sunset reading gives better results, but still shows a considerable number of carry-over maxima, and gives a mean temperature considerably higher than the midnight standard for all months of the year. The 8 a. m. and midnight values are very near the same for all months except February. In most cases, the carry-over minimum readings obtained by taking observations at 8 a. m. are offset by minimum temperatures occurring at midnight, each instance resulting in 2 low readings for 1 cold night; and 1 warm day in either case would give only 1 high maximum reading. Except in the winter, the temperature usually rises so much by 8 a. m. that there are few carry-over minima.

TABLE 1.—*Departure from midnight-to-midnight mean temperature obtained by taking observations at other times of the day (degrees Fahrenheit)*

Time of observation	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
5 p.m.	+1.0	+1.0	+1.1	+1.5	+1.3	+1.4	+1.2	+1.1	+1.4	+1.2	+1.0	+0.9	+1.2
Sunset	+1.0	+.4	+.5	+.6	+.5	+.4	+.3	+.3	+.4	+.6	+1.0	+.9	+.6
8 a.m.	−.3	−.6	−.2	+.2	0	+.2	+.3	+.1	−.1	−.2	−.3	0	−.1

From this table of differences between the midnight-to-midnight standard and mean temperatures obtained by taking readings at the other times of the day, it is evident that mean temperatures based on afternoon observations, especially if taken as early as 5 p. m., are considerably too high to be comparable with those based on the Weather Bureau standard of midnight-to-midnight, or the 8 a. m. readings; and that if it is desired to have cooperative readings that are comparable to regular Weather Bureau station records, observations taken at 8 a. m. will give the best results of any practicable time. It is impossible, of course, to obtain records based on the midnight-to-midnight period except at regular Weather Bureau stations. If for any reason it is necessary for a cooperative observer to take his readings during regular working hours (from 8 a. m. to 5 p. m.) the early morning hour will result in mean temperatures much more comparable with those recorded at a regular Weather Bureau station than if the observation is taken in the afternoon. It is recognized that difficulty is frequently experienced in determining the date on which maximum temperatures occur when based on morning observations, as some observers set them back 1 day and others do not; but it is believed that the advantages in obtaining records which are more nearly comparable with those made at regular Weather Bureau stations will more than offset this minor difficulty.

THE USE OF FREE-AIR SOUNDINGS IN GENERAL FORECASTING

By HORACE R. BYERS

The use of free-air soundings in general forecasting practice presents several difficulties, chief of which is the limited time allowed for analysis of the data. With a score or more of aeroplane sounding stations dotting the country, enough information should be available for approximating mathematical treatment of the forecast problem; but to utilize in this manner all of the data to their fullest extent is a task left to the research worker, who calculates the atmospheric conditions after the weather events have taken place. In the office of a weather service such as the United States Weather Bureau, less than 2 hours are allowed between the time the data of upper air soundings are received and the general forecasts are issued, so that no time is available for detailed analysis.

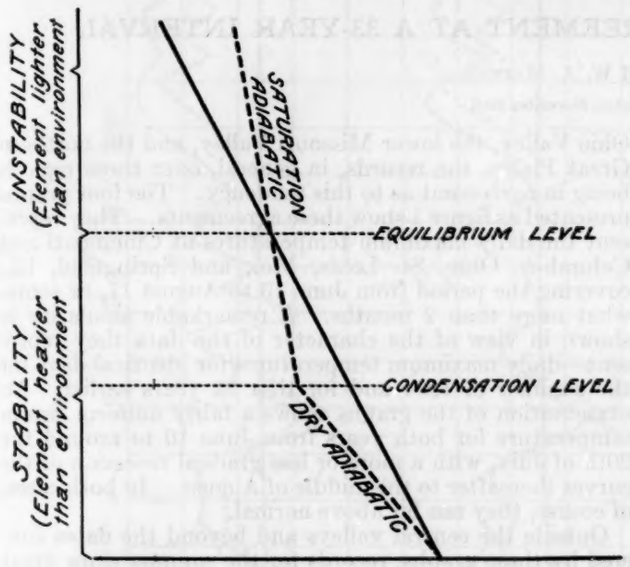
However, in this limited time much can be accomplished through the use of rapid graphical methods for determining the state of the atmosphere. Recent advances in the graphical representation of air-mass properties and new knowledge concerning the behavior of the upper air have been helpful. In the course of nearly a year's work in practical forecasting with the use of these data for most of the United States, the writer has found a highly satisfactory degree of success possible without the expenditure of a great deal of time.

Since superadiabatic lapse rates are rare and of little consequence in the free atmosphere, we need consider only instability with respect to saturated air in forecasting rain and storms. This, of course, assumes that we accept the principles of modern synoptic meteorology that heavy clouds and precipitation are formed almost exclusively by adiabatic cooling of moist air during upward motions; and that departures from equilibrium conditions in the vertical temperature distribution, to

which we give the name instability, are the determining factors in these vertical movements. For fogs and stratus clouds, such as those which are so prevalent in California, other cooling processes are of importance, for example, cooling by contact with a cold ocean surface or a radiation-cooled ground surface, and other factors in the vertical temperature curves should be given the principal consideration. In this brief discussion, however, attention is confined to the meteorological conditions for the formation of precipitation, assumed to be a result of adiabatic processes alone.

In general, four factors should be studied in connection with the soundings, as follows: First, the identification of the air masses; second, the changes that are taking place in the air masses as shown by comparison with previous data on the same masses; third, the present state of stability or instability of the air; and fourth, the changes in lapse rate which may be expected, especially if the air is lifted along a front or over large mountain areas.

The first question, that of air-mass identification, has been admirably discussed by Rossby (1) and by Willett



(2). The problem of changes taking place in the air-masses requires that the forecaster note especially the addition or subtraction of heat and moisture to the air-mass, and the development of subsidence, turbulence, and temperature inversions.

To test the present state of stability or instability of the air-mass, the Refsdal chart or Neuhoff diagram should be used, and the test made for what Refsdal has called conditional instability. The test consists of tracing the pressure-temperature or altitude-temperature curve of a rising element of the air which contains moisture but is not saturated. The dry adiabatic rate of cooling of 1° C. per 100 meters will be followed until saturation is reached, after which the air will cool at the slower saturation or moist adiabatic rate. If the prevailing lapse rate in the surrounding atmosphere is between the dry and saturation adiabatic rates, an element lifted upward would first encounter resistance to its vertical motion, because it would cool with altitude at the faster dry adiabatic rate; after condensation, it would follow the saturatinn adiabatic rate, which is slower than that of the surrouoding atmosphere, and pass from stable to unstable, that is, from heavier to lighter than its surroundings (fig. 1). This type of temperature distribution is called conditional instability, the conditions being (1) a sufficient amount of moisture in the air so that the moving element becomes saturated soon enough to follow a saturation adiabatic line which intersects the prevailing lapse rate curve, and (2) a strong enough mechanically-produced lifting to overcome the stabilizing forces at the lower levels and carry the element to the equilibrium point.

By tracing on the adiabatic chart the temperature-pressure relationships of an element lifted upward through the air in this manner, we have what is called an emagram, first used by Refsdal. Areas on the chart where the rising element is warmer than its surroundings are called positive areas and are usually shaded red. The parts where the moving air is colder are called negative areas, generally colored blue. The extent of these areas is supposed to be a measure of the convective energy available in the atmosphere. The tephigram, developed by Sir Napier Shaw, shows the same properties of the air, but has the disadvantage that it requires an additional chart.

Numerous objections to the emagram and tephigram and their forecasting value have been made recently. However, in our use of the emagram, we have found it of great value in forecasting instability showers and thunderstorms within an air-mass. It is especially useful in air-masses where these phenomena are likely to occur, such as the Tropical Gulf air.

The changes in the stability characteristics that result from changes in the lapse rate of the air produced in widespread bodily lifting of the air-mass were discussed by Rossby. (1). The characteristic of the air which for moist air makes its lapse rate change radically from stability to instability, Rossby calls convective instability; it has no reference to current stability characteristics of the atmosphere, but represents what one might call potential instability: The instability will materialize only in case the air is lifted and its potentialities thus realized. Rossby proved that convective instability in a layer is definitely indicated simply when the equivalent potential temperature decreases with height within the layer. Thus convective instability can be recognized at a glance on the Rossby or equivalent potential temperature diagram or some adaptation of it. At the Massachusetts Institute of Technology, 2 types of equivalent potential temperature diagrams are printed—1 containing pressures and temperatures of the condensation levels, and 1 without these quantities. For air-mass identification, the latter diagrams are preferable; but to determine the degree of convective instability, the pressure and temperature lines are necessary. The discussion of convective instability and how lifting affects the lapse rate is given in Rossby's apper and will not be repeated here. The fundamental idea is that if a layer of air has a much higher water vapor content at its bottom than at its top, the lower part will reach saturation first as the layer is lifted bodily, and will cool at the slow saturation adiabatic rate; the top, however, will cool at the much faster dry adiabatic rate, until it also becomes saturated. This results in the upper part of the layer becoming relatively much colder than the lower part, because of its faster rate of cooling. The consequence, of course, is a rapid rate of temperature fall with height within the layer, in other words, instability.

In addition to the four factors which have been listed above, it will be helpful in regions where there is a fairly large number of sounding stations, to construct latitudinal and longitudinal cross-sections of the atmosphere.

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Namias has suggested cross-sections of potential temperature, which can be drawn very quickly. Since unsaturated air maintains a constant potential temperature during vertical motions, places in the cross-section where the potential temperature lines dip downward would probably represent subsidence (or a transition from a colder to a warmer air mass), and those where the potential temperature lines slope upward would represent zones of rising air (or a transition from a warm to a colder air mass).

To return to the question of time, it has been the experience in TWA that to construct the adiabatic chart and the Rossby diagram requires about 10 minutes with the data received in the present Weather Bureau code. W. H. Clover has developed a code which we use in transmitting the data to forecast centers that do not receive the data from the Government; with the use of this code, which has the same number of characters as the Weather Bureau code, the time for decoding and plotting is cut in half.

With the use of the above-mentioned methods of aerological analysis, it should be possible for the forecaster making general forecasts to use at least half a dozen free air soundings in the forecasting practice without an appreciable sacrifice of time. A routine man in the forecast center could plot the data in half an hour's time and have it ready for the forecaster's inspection when the latter finishes his weather map analysis.

The writer is certain that no organization in the United States has thus far treated free-air soundings with the routine thoroughness practiced in the TWA (Transcontinental Western Air) meteorological organization in the past year; he therefore hopes that these remarks will be taken as the result of the serious application of aerological material to practical forecasting, for both the short periods covered by individual air transport flights and the longer period forecasts similar to the daily Weather Bureau forecast period.

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A REMARKABLE TEMPERATURE AGREEMENT AT A 33-YEAR INTERVAL

By J. B. KINCER and W. A. MATTICE
[Weather Bureau, Washington, November 1934]

In efforts to detect recurrences of a cyclic nature that possibly would serve as a basis for long-range forecasting a great deal of investigational work has been done and many papers published on the question of approximate repetitions in weather conditions at stated intervals of time. Many such cycles have either been claimed outright as more or less definitely established, or have been suggested as probably real and dependable in their recurring phases. However, it appears that when these are subjected to rigid tests they usually in the last analysis carry conviction of fortuity or chance combinations with no assurance of continued conformity in future years.

Most cases of recurrent agreements refer to conditions covering considerable periods of time, such as the average temperature for a month, a season, or a year. With numerous records we naturally would expect to find many cases of conformity when such periods are considered, but it would not be expected to find, except through the rarest of chance, a case in which the temperature distribution from day to day through a couple of months would be in close agreement with identical calendar days for the same period many years before.

However, a remarkable agreement of this character between maximum temperatures during the 1934 extremely hot summer in the interior States and the daily maxima in 1901 for the same period has come to light. The latter also was outstanding for abnormal heat in the area in question.

Attention was first called to this matter by a graph, prepared by the official in charge of the Weather Bureau station at Indianapolis, Ind., and published in the Indianapolis Star, July 25, 1934. The trend agreement from day to day between these summers, 33 years apart, was so striking that other station records were examined to determine how far this conformity extended geographically and for how long a period of time. This search disclosed marked agreement, considering the data in question, over the Ohio Valley, the lower Missouri Valley, and the northern Great Plains, the records, in general, over these regions being in agreement as to this tendency. The four graphs presented as figure 1 show these agreements. They represent the daily maximum temperatures at Cincinnati and Columbus, Ohio, St. Louis, Mo., and Springfield, Ill., covering the period from June 10 to August 17, or somewhat more than 2 months. A remarkable similarity is shown in view of the character of the data they represent—daily maximum temperatures for identical days for the summer of 1934 and for that 33 years earlier. An examination of the graphs shows a fairly uniform rise in temperature for both years from June 10 to around the 20th of July, with a more or less gradual recession of the curves thereafter to the middle of August. In both cases, of course, they ran far above normal.

Outside the central valleys and beyond the dates covered by these graphs, records for the summer show great divergences in this respect, with no conformity. Also, examination of other data during periods of abnormal temperature conditions, such as the 1934 cold February in the Northeastern States with other Februarys of past years disclosed no such day-to-day temperature agreement.

It appears that such remarkable and unexpected similarity in weather records, the very nature of which would seem to demand as explanation fortuitous combinations should serve to impress investigators of weather recurrences with the necessity for extreme caution in accepting concomitancy of records at time intervals, or apparent recurring phases, as definitely establishing progressions of a dependable cyclical nature. In other words, if agreements such as these can occur in daily maximum temperature data for a period of more than 2 months, the probability for chance combinations of various kinds would appear almost limitless when longer unit time periods are involved, such as a season or year.

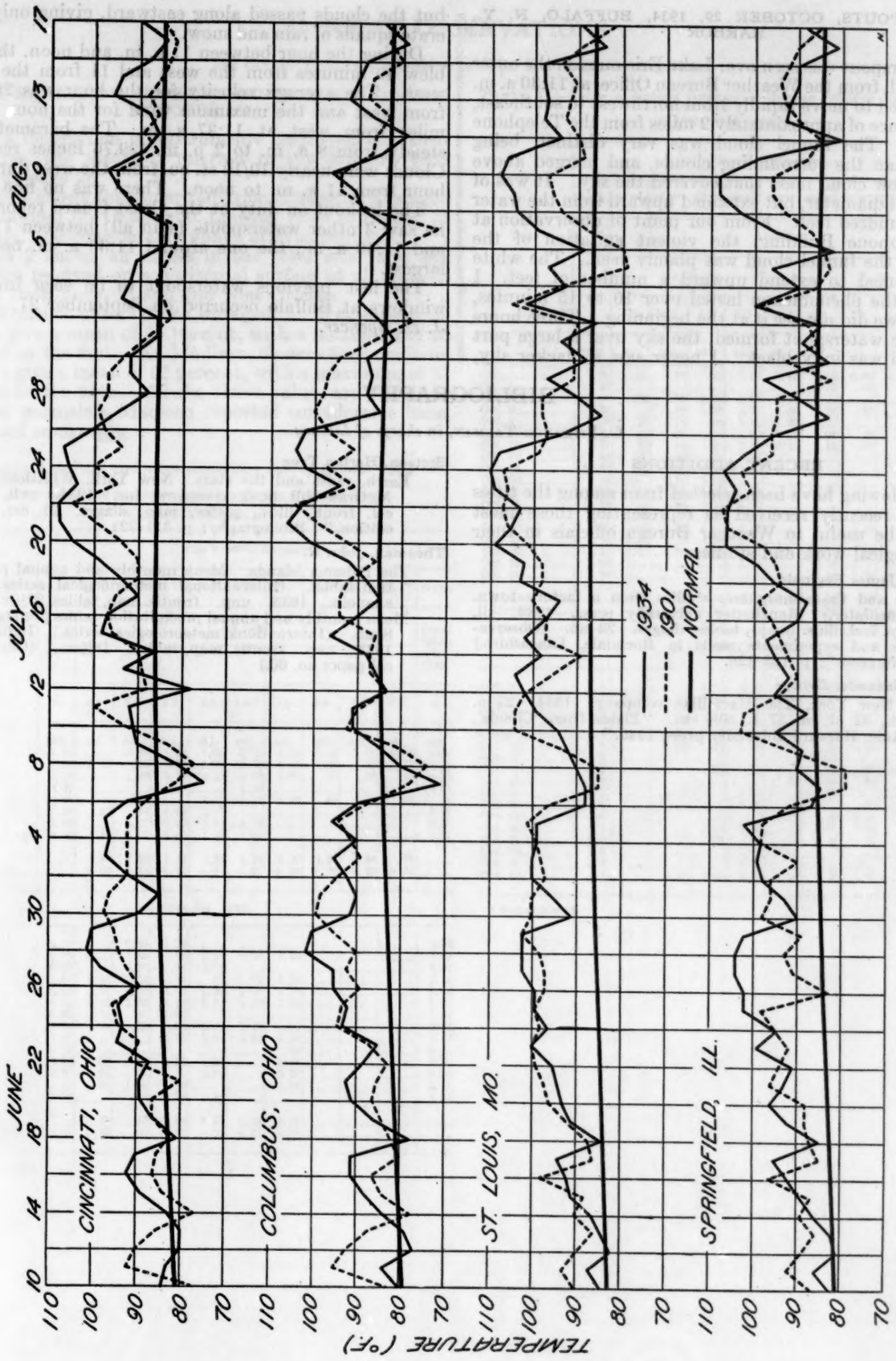

FIGURE 1.—Daily maximum temperatures, summers of 1901 and 1934.

WATERSPOUTS, OCTOBER 29, 1934, BUFFALO, N. Y., HARBOR

A waterspout was seen over Lake Erie outside the outer break wall, from the Weather Bureau Office, at 11:30 a. m. It appeared to move rapidly from northwest to southeast, at a distance of approximately 2 miles from the Telephone Building. The funnel cloud was very distinct, being darker than the surrounding clouds, and merged above into the low cloud mass that covered the sky. It was of very small diameter, but extended upward from the water several hundred feet. From our point of observation at the Telephone Building, the violent agitation of the water by the funnel cloud was plainly seen. The white spray seemed to extend upward a number of feet. I doubt if the phenomenon lasted over 10 to 15 minutes, although we did not see it at the beginning. Three hours before the waterspout formed, the sky over a large part of Buffalo was inky black. I never saw a blacker sky, but the clouds passed along eastward, giving only moderate squalls of rain and snow.

During the hour between 11 a. m. and noon, the wind blew 49 minutes from the west and 11 from the southwest. The average velocity for the hour was 26 miles from west and the maximum wind for the hour was 28 miles from west at 11:37 a. m. The barometer was steady from 8 a. m. to 2 p. m. (29.76 inches reduced). Clouds were nearly 10/10 st. cu. from the west during the hour from 11 a. m. to noon. There was no line squall.

The lookout on duty at the Coast Guard reports that he saw 3 other waterspouts (4 in all) between 11 a. m. and 11:40 a. m., the one around 11:30 a. m. being the largest.

The last previous waterspout to be seen from our windows at Buffalo occurred on September 27, 1928.—*J. H. Spencer.*

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C. FITZHUGH TALMAN, *in charge of Library*

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SOLAR OBSERVATIONS

By IRVING F. HAND, *Assistant in Solar Radiation Investigations*

SOLAR RADIATION MEASUREMENTS MADE DURING OCTOBER 1934

For a description of instruments employed and their exposures, the reader is referred to the January 1932 REVIEW, page 26.

Table 1 shows that solar radiation intensities averaged below normal for October at Lincoln, close to normal at Madison, and considerably above at Washington.

Table 2 shows an excess in the total solar and sky radiation received on a horizontal surface at all stations except Twin Falls, Miami and New Orleans.

Polarization observations obtained at Washington on 6 days give a mean of 54 percent, with a maximum of 60 percent on the first. At Madison, observations made on 11 days give a mean of 52 percent, with a maximum of 57 percent on the 25th. All the above values are below the October normals. Madison reported considerable haze, dust, and smoke.

TABLE 1.—*Solar radiation intensities during October 1934*

Gram-calories per minute per square centimeter of normal surface

WASHINGTON, D. C.

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer.	Air mass: A. M.					P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	1.0[1]	2.0	3.0	4.0	5.0	e
	mm	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm*
Oct. 1	7.04		0.93	1.04	1.29	1.62	1.35	1.16	1.01	0.94	6.50
Oct. 2	7.04	0.86	.94	1.03	1.19	1.54	1.19	1.00	.83	.71	6.50
Oct. 8	8.18		1.00	1.11	1.29	1.52	1.06	.92	.86	.72	6.50
Oct. 9	9.47					1.36					10.21
Oct. 11	10.59				1.10	1.38	1.06	.94	.78	.68	11.38
Oct. 12	7.29	.82	.94	1.03	1.17						6.27
Oct. 13	3.63		1.07	1.20	1.37	1.55					3.81
Oct. 20	4.75	.85	1.01	1.16	1.30	1.52					4.37
Means		.84	.98	**1.10**	**1.24**	**1.49**	**1.22**	**1.00**	.84	.76	
Departures		+.09	+.13	+.14	+.11	+.07	+.09	+.06	+.03	+.04	

MADISON, WIS.

Oct. 1	5.79		0.93	1.09							7.32
Oct. 2	8.48		.80	.92	1.21	1.50	1.23				7.87
Oct. 6	5.56		.70	.84	1.08						6.27
Oct. 10	7.57	0.44	.54	.71	.87	1.02	1.03				9.14
Oct. 11	9.14	.85	.96	1.08	1.23	1.50	1.26				8.48
Oct. 12	8.48	.96	1.05	1.17	1.27	1.60	1.20				7.04
Oct. 13	7.39	.75	.86	1.03							7.87
Oct. 15	6.76	.55	.68	.81	1.07	1.40					8.81
Oct. 22	7.57			1.21	1.34	1.58	1.30				7.87
Oct. 23	8.18						.96				9.14
Oct. 25	7.32	.88	1.03	1.18	1.34		1.34				5.36
Oct. 26	6.27	.82	1.01	1.19	1.25		1.27				6.76
Oct. 29	3.45	.96	1.09	1.26			1.34				3.45
Oct. 31	3.99		.82	.88	1.36						3.81
Means		.78	.87	**1.03**	**1.20**	**1.43**	**1.21**				
Departures		±.00	−.04	−.01	+.01	+.01	+.01				

[1] Extrapolated.

TABLE 1.—*Solar radiation intensities during October 1934*—Contd.

LINCOLN, NEBR.

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer.	Air mass: A. M.					P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	1.0[1]	2.0	3.0	4.0	5.0	e
	mm	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm*
Oct. 1	8.18	0.81	0.93	1.06	1.26	1.38					7.29
Oct. 2	7.04	.64	.76	.88	1.03	1.42	0.95	0.64	0.46	0.30	7.04
Oct. 5	10.21						1.13	.90	.72	.59	10.59
Oct. 6	4.95	.54	.76	1.00	1.14	1.49					3.81
Oct. 8	7.57		.86	1.06	1.23	1.50	1.16	.87	.67	.56	7.57
Oct. 9	7.29	.63	.74	.88	1.10	1.29					9.14
Oct. 10	7.87	.52	.63	.84	1.02	1.32	1.04	.78	.65	.54	9.83
Oct. 11	7.57	.63	.75	.88	1.10	1.49	1.12	.88	.76	.61	9.14
Oct. 12	7.57	.69	.80	.97	1.15						7.57
Oct. 16	12.24	.78	.85	1.16	1.32						7.04
Oct. 20	8.18		1.04	1.18							8.81
Oct. 22	7.57	.86	.96	1.07	1.33		1.33	1.16	.98	.88	9.83
Oct. 23	11.38	.73	.85	1.00	1.20						14.10
Oct. 25	4.75	.99					1.33	1.17	1.02	.86	4.75
Oct. 26	7.29	.83	.97	1.15	1.30		1.31	1.18	1.05	.94	8.48
Oct. 27	3.15	1.00	1.10	1.24	1.41						2.26
Oct. 29	3.15	1.02	1.13	1.22							2.87
Oct. 30	3.00				1.36		1.18				3.99
Oct. 31	3.30						1.32	1.26	1.16	1.01	3.45
Means		.76	.88	1.04	**1.21**	**1.41**	**1.19**	.98	.83	.70	
Departures		−.07	−.05	−.05	−.06	−.06	−.05	−.09	−.11	−.13	

BLUE HILL, MASS.

Oct. 2	5.4			1.10	1.30	1.52	1.25	1.00	0.80	0.69	7.2
Oct. 3	6.3	0.90	0.98	1.09	1.19	1.30	1.19				5.9
Oct. 7	7.4				1.27	1.40	1.22	.98	.79		6.4
Oct. 8	6.5		1.11	1.21	1.33	1.45					5.9
Oct. 9	4.8		1.09	1.22	1.38	1.55	1.36	1.15	.88		3.5
Oct. 10	3.5		1.23	1.32	1.42	1.52	1.34	1.12	.94	.79	3.7
Oct. 12	4.6						1.32				3.4
Oct. 14	3.8			1.28	1.38	1.51	1.31	1.09	.95		3.3
Oct. 16	5.4					1.39	1.15	.88	.65		6.0
Oct. 17	7.1				1.10		.90				7.6
Oct. 20	4.8				1.00			.95			5.8
Oct. 24	6.5						1.28	1.06			6.5
Oct. 25	5.4			1.03	1.25		1.27	1.08	.94		6.2
Oct. 27	5.0		1.11	1.26	1.42		1.43	1.34			3.8
Oct. 28	2.8				1.43						2.2
Oct. 29	3.5				1.38						3.2
Oct. 30	4.0		1.19	1.33	1.32		1.26	.90			2.3

[1] Extrapolated.

TABLE 2.—*Average daily totals of solar radiation (direct + diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Pittsburgh	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	Mount Washington	Friday Harbor
	Gram calories per square centimeter															
1934	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
Oct. 1	344	308	392	329	322	462	249	141	332	406	408	232	386	339	313	
Oct. 8	376	324	359	360	351	458	312	71	358	363	394	286	381	322	220	275
Oct. 15	333	161	244	198	219	335	242	45	242	385	336	306	295	220	258	202
Oct. 22	234	231	329	235	149	390	151	49	262	363	387	321	376	202	192	146
	Departures from weekly normals															
Oct. 1	+11	+34	+59	+86	+48	+26	−8	+40	−77		−18	−100				
Oct. 8	+65	+78	+51	+150	+81	+51	+84	−5	−18		−4	−46				
Oct. 15	+53	−58	−59	+12	+16	−45	+39	−13	−106		−43	−15				
Oct. 22	−32	+29	+51	+67	−40	+37	−29	±0	−35		+11	+51				
	Accumulated departures on Oct. 29															
	+2,373	−2,954	+7,219		+13,526	+9,464	−1,897	+287	−6,475		−7,462	+6,265				

TABLE 3.—*Total, I_m, and screened, I_y, I_r, solar radiation intensity measurements, obtained during October 1934, and determinations of the atmospheric turbidity factor, β, and water-vapor content, w=depth in millimeters, if precipitated. American University, Washington, D. C.*

Date and hour angle	Solar altitude	Air mass	I_m	I_y	I_r	β_{I_m-r}	β_{I_y-r}	βmean	$\frac{I_{w=0}}{1.94}$	$\frac{I_{w=0}-I_m}{1.94}$	w.	Air-mass type
									Percentage of solar constant			
Oct. 1	° ′	*m*	gr. cal.	gr. cal.	gr. cal.						*mm*	
0:17 a. m.	47 49	1.34	1.516	1.032	0.819	0.052	0.026	0.039	83.2	5.0	2	P_c.
Oct. 2												
4:48 a. m.	12 24	4.61	.913	.710	.597	.046	.050	.048	56.9	9.7	4	P_c.
4:44 a. m.	13 09	4.34	.916	.710	.597	.048	.056	.052	56.5	8.3	3	
4:25 a. m.	15 56	3.61	.949	.769	.618	.065	.035	.050	61.0	12.0	9	
4:20 a. m.	16 51	3.45	.970	.770	.619	.060	.040	.050	62.0	12.0	10	
4:12 a. m.	18 19	3.21	1.002	.787	.638	.056	.042	.054	63.0	11.3	9	
4:08 a. m.	19 02	3.10	1.025	.809	.647	.060	.038	.049	64.7	11.9	11	
4:04 a. m.	19 46	2.98	1.030	.809	.648	.066	.038	.052	64.8	11.7	12	
4:00 a. m.	20 29	2.86	1.061	.809	.661	.058	.054	.056	65.0	10.3	7	
3:56 a. m.	21 12	2.74	1.070	.810	.662	.062	.060	.061	69.3	14.1	30	
3:17 a. m.	28 04	2.12	1.178	.911	.717	.070	.030	.050	72.6	11.9	18	
3:13 a. m.	28 44	2.07	1.198	.912	.718	.060	.032	.046	73.8	12.0	17	
3:09 a. m.	29 12	2.03	1.212	.907	.736	.068	.062	.065	71.8	8.3	4	
3:05 a. m.	30 01	2.00	1.192	.907	.737	.079	.065	.072	70.0	8.6	4	
1:37 a. m.	42 00	1.49	1.332	.987	.784	.068	.020	.044	80.0	11.3	15	
1:32 a. m.	42 33	1.48	1.378	.989	.774	.044	.020	.032	82.0	11.0	14	
0:52 a. m.	45 57	1.39	1.357	1.001	.770	.058	.026	.042	81.5	11.4	18	
0:48 a. m.	46 12	1.39	1.359	1.001	.770	.056	.024	.041	81.5	11.4	18	
0:39 a. m.	46 39	1.38	1.377	.986	.771	.048	.022	.035	82.2	11.1	16	
0:35 a. m.	46 50	1.37	1.366	.992	.776	.066	.022	.044	81.2	10.7	14	
0:31 a. m.	47 00	1.37	1.355	.993	.776	.070	.020	.045	81.0	11.1	14	
Oct. 8												
3:10 a. m.	27 19	2.17	1.264	.933	.726	.035	.015	.025	78.2	13.0	24	P_y.
3:06 a. m.	27 59	2.12	1.272	.934	.727	.032	.018	.025	78.6	13.0	24	
1:47 a. m.	39 54	1.56	1.347	.963	.754	.038	.022	.030	81.6	12.2	20	
1:42 a. m.	40 20	1.54	1.374	.964	.758	.030	.024	.027	82.4	11.6	16	
0:26 a. m.	44 55	1.41	1.397	.986	.765	.034	.040	.037	82.4	10.4	12	
0:21 a. m.	45 01	1.41	1.411	.986	.765	.024	.040	.032	82.8	10.1	10	
Oct. 11												
3:00 a. m.	28 03	2.12	1.052	.795	.619	.078	.046	.062	71.2	17.1	>50	N_{PP}.
2:55 a. m.	28 49	2.07	1.102	.796	.620	.056	.048	.052	77.2	20.4	>50	
0:20 a. m.	43 53	1.44	1.255	.893	.693	.066	.044	.055	78.2	13.5	35	
0:16 a. m.	44 00	1.44	1.258	.893	.693	.066	.046	.056	78.0	13.2	32	
Oct. 12												
4:14 a. m.	15 20	3.74	.980	.752	.620	.046	.050	.048	60.9	10.5	5	P_c.
4:10 a. m.	16 02	3.59	.980	.752	.620	.052	.054	.053	60.4	10.0	4	
3:35 a. m.	22 06	2.64	1.111	.823	.670	.052	.062	.057	67.1	9.8	5	
3:31 a. m.	22 46	2.57	1.120	.824	.671	.049	.065	.057	67.0	9.4	4	
3:11 a. m.	26 00	2.28	1.139	.844	.689	.068	.072	.070	67.4	8.8	4	
3:07 a. m.	26 38	2.23	1.139	.848	.690	.069	.073	.071	67.8	9.2	4	

Atmospheric conditions during turbidity measurements.

Oct. 1. Temperature, 15° C.; wind, NE 10; vis., 50 miles; polarization, 60 percent; blueness of sky, 6.

Oct. 2. Temperature, 14° C.; wind, NE 6; vis., 30 miles; polarization, 59 percent; blueness of sky, 5.

Oct. 8. Temperature, 14° C.; wind, SW 10; vis., 30 miles; polarization, 55 percent; blueness of sky, 4–5.

Oct. 11. Temperature, 17° C.; wind, SW 11; vis., 20 miles; polarization, 50 percent; blueness of sky, 4.

Oct. 12. Temperature, 14° C.; wind, NW 15; vis., 20 miles; polarization, 48 percent; blueness of sky, 4.

BLUE HILL METEOROLOGICAL OBSERVATORY OF HARVARD UNIVERSITY

Date and hour angle [1]	Solar altitude	Air mass	I_m	I_y	I_r	β_{I_m-r}	β_{I_y-r}	βmean	$\frac{I_{w=0}}{1.94}$	$\frac{I_{w=0}-I_m}{1.94}$	w	Air-mass type
									Percentage of solar constant			
Oct. 2	° ′	*m*	gr. cal.	gr. cal.	gr. cal.						*mm*	
3:12	26 58	2.20	1.251	0.897	0.732	0.040	0.062	0.051	71.8	7.2	2.5	P_c.
1:16	41 08	1.52	1.382	.951	.757	.036	.051	.044	76.0	4.7	1.2	
0:28	43 41	1.45	1.406	.970	.776	.033	.057	.045	80.4	7.8	4.2	
1:26	40 18	1.54	1.377	.995	5.759	.031	.049	.040	79.4	8.3	4.7	
4:30	14 00	4.08	0.757	.605	.492	.074	.063	.068	54.0	14.9	29.0	
Oct. 3												
2:56	29 04	2.06	1.181	.841	.680	.052	.073	.062	71.0	10.1	7.5	N_{TP}.
2:40	31 21	1.92	1.196	.846	.685	.057	.082	.070	71.0	9.3	3.9	
1:17	40 41	1.53	1.193	.840	.692	.095	.146	.120	68.8	7.3	3.1	
Oct. 7												
3:25	24 06	2.44	1.121	.833	.672	.057	.058	058	68.4	6.5	1.4	N_{PP}.
Oct. 8												
3:59	17 40	3.26	1.175	.856	.695	.019	.035	.027	70.7	5.0	0.6	N_{PP}.
2:02	34 42	1.75	1.346	.938	.744	.026	.037	.032	80.2	10.9	5.8	
1:55	35 13	1.73	1.244	.876	.707	.056	.081	.068	73.3	8.2	4.0	
Oct. 9												
3:57	17 42	3.26	1.237	.917	.752	.021	.030	.026	70.9	7.2	1.4	P_c; P_T.
1:58	34 25	1.77	1.433	1.025	.823	.027	.029	.028	80.9	7.2	2.5	
0:47	40 26	1.54	1.459	1.029	.826	.027	.036	.032	81.6	6.5	2.2	
0:18	41 31	1.51	1.467	1.036	.835	.032	.044	.038	81.1	5.6	1.5	
2:33	35 00	1.74	1.350	.971	.787	.048	.057	.052	76.7	7.3	2.6	
Oct. 10												
3:45	19 21	3.00	1.298	.949	.771	.012	.024	.018	75.0	8.3	2.4	P_c; P_T.
1:50	34 22	1.77	1.447	1.023	.828	.024	.043	.034	81.0	6.6	2.1	
0:46	40 08	1.55	1.439	1.019	.826	.037	.057	.047	79.1	5.1	1.2	
3:18	23 37	2.51	1.224	.909	.757	.067	.068	.068	65.5	2.6	0.7	
4:25	12 41	4.47	.865	.702	.596	.070	.065	.068	52.5	8.1	1.4	
Oct. 14												
1:08	37 22	1.64	1.435	1.008	.823	.034	.062	.048	78.6	5.0	1.1	P_c.
0:43	38 46	1.59	1.433	1.022	.823	.038	.043	.040	80.0	6.5	2.0	
Oct. 16												
1:21	35 44	1.71	1.220	.889	.716	.079	.076	.078	71.6	9.1	6.0	P_c.
2:39	27 23	2.17	1.123	.830	.672	.072	.074	.073	68.0	10.5	8.5	
Oct. 17												
3:08	23 10	2.53	1.123	.842	.682	.054	.056	.055	67.1	9.6	5.0	N_{PC}.
2:30	28 09	2.12	.864	.659	.554	.162	.179	.170	51.6	7.4	2.2	
Oct. 20												
3:37	17 46	3.24	.914	.724	.601	.084	.079	.082	56.3	9.6	3.9	P_c.
Oct. 24												
0:01	36 06	1.69	1.121	.853	.690	.072	.100	.086	69.6	7.9	3.6	N_{PC}.
1:31	37 32	1.86	1.314	.941	.737	.059	.024	.042	77.3	10.3	9.2	
1:54	30 06	1.99	1.272	.928	.747	.052	.051	.052	73.6	8.8	4.8	
3:37	16 44	3.45	.947	.739	.604	.065	.058	.062	58.9	10.6	5.5	
3:45	15 29	3.49	.918	.722	.599	.074	.071	.072	56.7	9.8	4.0	

[1] p. m. hour angles in italics.

BLUE HILL METEOROLOGICAL OBSERVATORY OF HARVARD UNIVERSITY—Continued

Date and hour angle	Solar altitude	Air mass	I_m	I_y	I_r	$\beta_{I_{m-r}}$	$\beta_{I_{y-r}}$	β_{mean}	$\frac{I_{w-e}}{1.94}$ Percentage of solar constant	$\frac{I_{w-e}-I_m}{1.94}$ Percentage of solar constant	w	Air-mass type
Oct. 25	° ′	*m*	*gr. cal.*	*gr. cal.*	*gr. cal.*						*mm*	
1:24	32 29	1.86	1.269	0.903	0.738	0.057	0.085	0.071	71.5	6.8	2.1	N_{Pc} (or P_A
0:43	34 51	1.75	1.320	.944	.756	.058	.025	.042	77.0	9.7	3.4	
3:34	16 55	3.41	.996	.776	.632	.058	.049	.054	57.6	6.8	1.2	P_c.
Oct. 27												
1:28	31 54	1.89	1.446	1.032	.828	.049	.025	.037	77.9	4.3	0.6	
0:06	35 03	1.74	1.438	1.018	.816	.025	.049	.037	79.2	6.0	1.5	
Oct. 29												
1:39	30 05	1.99	1.364	.978	.792	.036	.046	.041	76.2	6.9	2.0	P_c.
Oct. 30												
3:38	14 32	3.94	1.214	.921	.752	.014	.018	.016	68.9	7.2	1.2	P_c.
1:08	31 22	1.92	1.314	.951	.763	.042	.046	.044	75.1	8.3	3.8	
0:57	32 33	1.86	1.308	.943	.765	.053	.065	.059	73.7	7.2	2.4	

ATMOSPHERIC CONDITIONS DURING SOLAR RADIATION MEASUREMENTS, BLUE HILL OBSERVATORY OF HARVARD UNIVERSITY

Date and time from apparent noon	Air temperature	Wind (Beaufort scale)	Visibility scale, 0–10	Sky blueness	Clouds and remarks
October 1934	°C				
2, 3:46 a. m.	5.66	NNE 4	5–8	8	2 Acu.
2, 1:36 a. m.	11.1	ExN 3	9	6	1 Ast, 1 Cu. Smk. in W–N.
2, 1:18 p. m.	12.2	ExN 2	9	6	2 Ci, few Frcu.
2, 4:27 p. m.	12.2	E 2	9	7	1 Ci, lt. hz.
3, 2:43 a. m.	12.6	N 2	8	8	Few Ci.
3, 1:29 a. m.	15.1	NW 2	8	8	1 Ci.
7, 2:17 a. m.	14.4	WxN 7	-------	6	7 Frcu.
7, 1:18 p. m.	15.6	WxN 7	-------	4	7 Cu.
7, 3:46 p. m.	15.0	WNW 7	-------	4	3 Cu.
8, 4:04 a. m.	9.0	W 6	8	12	0 clouds.
8, 2:08 a. m.	13.9	WxS 6	9	7	Few Acu.
8, 2:04 p. m.	19.2	WxS 6	9	-------	0 clouds.
8, 4:44 p. m.	20.0	W 5	9	-------	Few Cu, lt. hz.
9, 3:50 a. m.	9.4	NW 3	8	12	Few Ci.
9, 1:58 a. m.	13.9	WNW 5	9	7	4 Ci.
9, 0:20 p. m.	13.3	WNW 4	9	8	2 Ci.
9, 3:25 p. m.	13.6	W 2	9	-------	Few Ci, few Acu.
10, 3:49 a. m.	4.3	NW 6	8	12	2 Ci.
10, 1:52 a. m.	7.2	NW 3	9	6	5 Ci.
10, 0:46 p. m.	10.9	SWxS 2	9	-------	2 Ci.
10, 4:18 p. m.	13.6	WSW 2	9	8	1 Ci, few Acu.
14, 3:24 a. m.	4.3	NW 9	9	11	Few Acu, few Cu.
14, 1:08 a. m.	7.8	NN 5	9	8	Few Cu.
14, 0:40 p. m.	8.3	NW 5	9	-------	Few Ci, 1 Cu.
14, 3:51 p. m.	10.0	WNW 4	10	-------	1 Ci in E; few Cu.
16, 0:27 p. m.	9.4	NE 1	8	8	2 Cu.
16, 2:40 p. m.	9.9	NNE 2	-------	-------	Few Ci in S.
16, 4:18 p. m.	9.4	ENE 3	-------	7	0 clouds; smk. on hor'n.
17, 3:12 a. m.	10.0	SW 3	8	8	Clear.
17, 1:32 a. m.	13.3	SSW 2	+8	-------	4 Ci. (dense); mod. hz.
17, 2:40 p. m.	16.7	SSW 3	8	6	0 clouds; mod. to dns. hz.
17, 4:04 p. m.	15.0	SWxS 4	8	6	0 clouds, mod. hz.
20, 2:25 a. m.	6.7	WNW 4	8	6	Few Ci, 1 Cu.
20, 3:36 p. m.	11.7	WNW 4	8	9	1 Ci.
24, 12 noon	9.4	NExE 4	9	6	1 Cu & Frcu fumules.
24, 1:32 p. m.	10.6	NExE 4	9	7–8	1 Stcu, hy. smk. N & NW.
24, 3:40 p. m.	11.7	NExN 4	9	7	Few Acu, lt. hz., smk.
25, 3:07 a. m.	9.4	N 3	7	10	Few Acu in west.
25, 1:30 a. m.	10.0	N 3	-------	10	1 Ci in W.
25, 0:42 p. m.	12.0	NNE 3	-------	8	1 Ci in W.
26, 3:33 p. m.	10.5	NNE 2	-------	8	Few Ci in W.
27, 3:21 a. m.	4.5	WNW 5	+9	-------	Few Frcu, few Acu.
27, 2:24 a. m.	5.0	WNW 5	-------	6	Few Frcu, few Acu.
27, 1:29 a. m.	6.1	WNW 7	9	8	1 Ast, few Frcu, lt. smk.
27, 1:07 p. m.	7.2	NWxW 6	9	-------	Few Ci, 1 Acu, few Frcu.
29, 1:41 a. m.	6.1	SW 3	9	7	1 Cl, few Acu, few Cu.
30, 3:40 a. m.	1.1	WSW 4	8	9	1 Cl, few Acu.
30, 1:09 a. m.	6.7	WSW 4	9	-------	Few Cu.
30, 0:56 p. m.	13.4	W 5	-------	7	1 Cu.

POSITIONS AND AREAS OF SUN SPOTS

Communicated by Capt. J. F. Hellweg, U. S. Navy, Superintendent U. S. Naval Observatory. Data furnished by the U. S. Naval Observatory in cooperation with Harvard and Mount Wilson Observatories. The difference in longitude is measured from the central meridian, positive west. The north latitude is positive. Areas are corrected for foreshortening and are expressed in millionths of the sun's visible hemisphere. The total area for each day includes spots and groups]

Date	Eastern standard time	Heliographic: Diff. in longitude	Heliographic: Longitude	Heliographic: Latitude	Area: Spot	Area: Group	Total area for each day	Observatory
1934	*h m*							
Oct. 1	11 21		No spots		-------	-------	-------	U. S. Naval.
Oct. 2	11 29		No spots		-------	-------	-------	Do.
Oct. 3	11 11		No spots		-------	-------	-------	Do.
Oct. 4	9 35		No spots		-------	-------	-------	Mt. Wilson.
Oct. 5	9 20		No spots		-------	-------	-------	Do.
Oct. 7	12 22		No spots		-------	-------	-------	U. S. Naval.
Oct. 8	11 10		No spots		-------	-------	-------	Do.
Oct. 9	11 38		No spots		-------	-------	-------	Do.
Oct. 10	11 0		No spots		-------	-------	-------	Mt. Wilson.
Oct. 11	11 25		No spots		-------	-------	-------	U. S. Naval.
Oct. 12	11 56	−64.0	74.9	−22.0	46	-------	46	Do.
Oct. 13	11 6	−51.0	75.1	−22.5	39	-------	39	Do.
Oct. 14	11 36	−37.5	75.2	−22.5	27	-------	27	Do.
Oct. 15	11 44	−24.5	74.9	−22.5	27	-------	27	Do.
Oct. 16	11 10	−12.0	74.5	−22.0	15	-------	15	Do.
Oct. 17	14 14	+4.0	75.6	−22.0	15	-------	15	Do.
Oct. 18	11 8	+16.0	76.1	−22.0	15	-------	15	Do.
Oct. 19	11 32		No spots		-------	-------	-------	Do.
Oct. 20	11 14		No spots		-------	-------	-------	Do.
Oct. 21	11 10		No spots		-------	-------	-------	Mt. Wilson.
Oct. 22	11 53	−22.5	344.5	+24.0	39	-------	39	U. S. Naval.
Oct. 23	13 14	−8.5	344.6	+23.0	15	-------	15	Do.
Oct. 24	9 30		No spots		-------	-------	-------	Mt. Wilson.
Oct. 25	11 58	−80.0	247.4	+4.5	31	-------	31	U. S. Naval.
Oct. 26	11 22	−65.5	249.0	+4.5	46	-------	46	Do.
Oct. 27	12 0	−51.0	250.0	+5.0	27	-------	27	Mt. Wilson.
Oct. 28	11 53	−39.0	248.9	+4.5	31	-------	31	U. S. Naval.
Oct. 29	13 56	−24.5	249.0	+4.5	31	-------	31	Do.
Oct. 30	11 17	−11.5	250.3	+4.5	15	-------	15	Do.
Oct. 31	13 15	−80.0	167.5	+23.0	-------	123	123	Do.

Mean daily area for 30 days, 18.

PROVISIONAL SUN-SPOT RELATIVE NUMBERS FOR OCTOBER 1934

(Dependent alone on observations at Zurich and its station at Arosa)

[Data furnished through the courtesy of Prof. W. Brunner, Eidgenossische Sternwarte, Zurich, Switzerland]

October 1934	Relative numbers	October 1934	Relative numbers	October 1934	Relative numbers
1	15	11	7	21	0
2	0	12	8	22	7
3	0	13	8	23	8
4	8?	14	8	24	0
5	0	15	-------	25	7
6	0	16	-------	26	7
7	0	17	8	27	7
8	0	18	8	28	7
9	0	19	14	29	10
10	0	20	0	30	16
				31	8

Mean, 29 days=5.6.

AEROLOGICAL OBSERVATIONS

Aerological Division, D. M. LITTLE, in Charge

By L. T. SAMUELS

The mean monthly free-air temperatures ranged from 15.7° C. over Kelly Field, to 2.8° C. over Mitchel Field at the 2,000-meter level; and from −1.5° C. over Fort Crockett to −12.6° C. over Mitchel Field at the 5,000-meter level. At Omaha, one of the few stations having a sufficiently long record for the determination of a normal, the free-air temperatures averaged considerably above normal.

The mean monthly free-air relative humidities ranged from 37 percent over Fort Crockett to 62 percent over Mitchel Field and 64 percent over Seattle at the 2,000-meter level; and from 23 percent over Kelly Field to 53 percent over Mitchel Field and Seattle at the 5,000-meter level.

Resultant free-air wind directions at the 2,000-meter level deviated most from normal along the Pacific coast, where a greater southerly component occurred. (See table 2.) Resultant velocities at that level were moderately above normal in most cases. At the 4,000-meter level the resultant directions showed a greater northerly component than normal over the Gulf region, and above normal velocities over the same region, with close to normal resultant directions and generally less than normal resultant velocities elsewhere at that level.

TABLE 1.—*Free-air temperatures and relative humidities obtained by airplanes during October 1934*

TEMPERATURE (° C.)

Station	Altitude (m) m. s. l.															
	Surface		500		1,000		1,500		2,000		2,500		3,000		4,000		5,000	
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal
Billings, Mont.[1] (1,090 m)	7.9						11.5		10.7		8.0		5.0		−2.0		−8.3	
Boston, Mass.[2] (6 m)	8.4		7.6		5.5		5.5		4.1		1.9		−.2		−5.4		−12.0	
Cheyenne, Wyo.[1] (1,873 m)	5.9								7.8		9.0		6.5		−.7		−8.2	
Fargo, N. Dak.[1] (274 m)	6.4		8.4		9.4		7.8		5.5		3.0		.3		−5.4		−11.6	
Fort Crockett (Galveston), Tex.[3] (3 m)	22.2		22.2		19.3		17.2		15.5		13.1		10.4		5.0		−1.5	
Kelly Field (San Antonio), Tex.[3] (211 m)	17.8		20.7		20.3		17.6		15.7		13.5		10.4		4.1		−2.7	
Lakehurst, N. J.[4] (3 m)	7.5		8.7		7.0		5.8		3.9		1.4		−.6		−6.1		−12.3	
Maxwell Field (Montgomery), Ala.[3] (52 m)	15.1		19.0		17.0		14.9		12.6		10.4		8.1		2.2		−4.1	
Mitchel Field (Hempstead, Long Island), N. Y.[3] (39 m)	8.5		8.0		5.9		4.4		2.8		.8		−1.4		−6.6		−12.6	
Murfreesboro, Tenn.[1] (174 m)	11.3		15.2		14.2		12.2		10.3		8.6		6.4		.4		−5.7	
Norfolk, Va.[4] (3 m)	13.2	−1.1	13.4	−0.1	10.7	−0.3	9.1	−0.1	7.3	+0.1	5.0	−0.1	2.4	−0.4	−2.3	−0.4	−7.7	−0.4
Oklahoma City, Okla.[1] (391 m)	14.2		16.4		18.9		16.7		14.0		11.1		7.7		.8		−5.4	
Omaha, Nebr.[1] (300 m)	10.6	(6)	12.6	(6)	15.2	+6.0	13.3	+5.6	11.0	+5.5	8.2	+5.3	5.1	+4.9	−1.2	+3.8	−7.7	+3.2
Pearl Harbor, Territory of Hawaii[4] (5 m)	23.2	−4.2	22.2	−.6	18.6	+.1	15.3	−.3	13.2	.0	11.4	−.2	9.3	−.6	3.5	−.6	−2.8	−.6
Pensacola, Fla.[4] (2 m)	17.5	−.6	18.0	+.3	15.5	−.2	13.3	−.3	10.9	−.7	8.6	−.8	6.2	−.9	.9	−.8	−4.8	−.5
San Diego, Calif.[4] (10 m)	15.9	−2.5	16.8	−.9	18.9	+.8	17.5	+1.2	15.2	+.9	12.7	+.9	9.8	+1.1	3.6	+1.4	−2.4	+1.5
Scott Field (Belleville), Ill.[3] (135 m)	9.9		15.5		14.4		12.2		9.8		7.3		4.4		−1.7		−7.6	
Seattle, Wash.[4] (8 m)	12.7	−1.0	12.7	.0	11.7	+.5	9.5	+.2	7.4	.0	4.9	−.1	2.7	.0	−2.4	+.6	−9.3	+.6
Selfridge Field (Mount Clemens), Mich.[3] (177 m)	7.8		10.3		9.1		7.7		5.9		4.0		1.6		−4.3		−10.3	
Spokane, Wash.[5] (596 m)	8.2				9.4		8.6		6.4		3.6		1.1		−4.8		−11.1	
Washington, D. C.[4] (2 m)	9.5	−2.8	10.3	−1.5	8.3	−1.6	6.5	−1.5	4.9	−1.1	3.2	−.9	.9	−1.2	−4.4	−1.5	−10.0	−1.5
Wright Field (Dayton), Ohio[3] (244 m)	7.7		10.0		10.9		9.2		7.3		5.3		3.1		−2.8		−9.3	

RELATIVE HUMIDITY (PERCENT)

Billings, Mont.[1] (1090 m)	65						52		46		44		44		44		43	
Boston, Mass.[2] (6 m)	79		70		68		52		45		43		38		33		38	
Cheyenne, Wyo.[1] (1873 m)	56								53		43		37		36		36	
Fargo, N. Dak.[1] (274 m)	83		73		61		53		48		47		45		43		41	
Fort Crockett (Galveston), Tex.[3] (3 m)	83		69		66		49		37		37		35		26		25	
Kelly Field (San Antonio), Tex.[3] (211 m)	85		78		65		62		47		38		35		28		23	
Lakehurst, N. J.[4] (3 m)	86		71		69		64		52		45		40		44		40	
Maxwell Field (Montgomery), Ala.[3] (52 m)	90		60		57		51		45		35		28		26		28	
Mitchel Field (Hempstead, L. I.), N. Y.[3] (39 m)	88		76		75		69		62		58		55		55		53	
Murfreesboro, Tenn.[1] (174 m)	88		68		62		57		53		45		43		41		37	
Norfolk, Va.[4] (3 m)	80	+4	68	+1	64	+1	56	−1	49	−2	44	−1	41	+1	32	+1	28	+1
Oklahoma City, Okla.[1] (391 m)	84		73		53		52		49		46		45		44		34	
Omaha, Nebr.[1] (300 m)	78	(6)	68	(6)	51	−5	48	−5	46	−7	44	−8	42	−8	40	−6	35	−8
Pearl Harbor, Territory of Hawaii[4] (5 m)	84	+17	80	+7	81	+3	76	+4	67	+3	58	+7	51	+13	43	+13	39	+13
Pensacola, Fla.[4] (2 m)	80	+1	66	−5	65	−2	58	−3	51	−4	42	−8	36	−9	32	−8	28	−9
San Diego Calif.[4] (10 m)	85	+14	74	+9	51	+4	44	+4	38	+5	36	+6	34	+7	33	+7	30	+7
Scott Field (Belleville), Ill.[3] (135 m)	89		58		53		49		45		40		36		37		33	
Seattle, Wash.[4] (8 m)	84	+3	76	+2	72	+4	69	+7	64	+8	64	+10	56	+8	52	+6	53	+6
Selfridge Field (Mount Clemens), Mich.[3] (177 m)	80		67		62		55		46		39		35		34		31	
Spokane, Wash.[5] (596 m)	82				72		64		60		60		55		51		49	
Washington, D. C.[4] (2 m)	72	−2	60	−4	58	−3	55	−4	47	−8	40	−9	39	−5	31	−4	25	−4
Wright Field (Dayton), Ohio[3] (244 m)	84		72		57		49		41		33		30		31		27	

[1] Weather Bureau.
[2] Massachusetts Institute of Technology.
[3] Army.
[4] Navy.
[5] National Guard.
[6] Surface and 500-meter level departures omitted because of difference in time of day between airplane observations and those of kites upon which the normals are based. Means based on only 18 observations at Mitchel Field and 16 observations at Seattle.

Observations taken about 5 a. m., 75th meridian time, except along the Pacific coast and Hawaii where they are taken about 5 a. m., local standard time.

TABLE 2.—*Free-air resultant winds (meters per second) based on pilot balloon observations made near 7 a. m. (E. S. T.) during October 1934*

Altitude (m) m. s. l.	Albuquerque, N. Mex. (1,554 m)		Atlanta, Ga. (309 m)		Bismarck, N. Dak. (518 m)		Brownsville, Tex. (7 m)		Burlington, Vt. (132 m)		Cheyenne, Wyo. (1,873 m)		Chicago, Ill. (192 m)		Cleveland, Ohio (245 m)		Dallas, Tex. (154 m)		Havre, Mont. (762 m)		Jacksonville, Fla. (14 m)		Key West, Fla. (11 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
Surface	3	2.0	9	1.4	324	0.4	10	0.6	200	1.7	276	4.8	262	1.1	218	1.8	132	1.3	287	1.2	341	1.2	67	2.5
500	------	------	46	1.9	------	------	122	4.0	225	4.1	------	------	267	4.1	253	4.4	174	6.0	------	------	39	2.9	72	5.9
1,000	------	------	30	1.3	278	4.1	123	3.2	271	6.9	------	------	283	5.8	281	5.9	192	5.7	257	3.9	60	1.1	90	5.0
1,500	------	------	299	2.3	283	5.6	105	1.6	283	8.9	------	------	289	7.1	281	7.0	224	3.8	285	5.5	305	1.2	103	3.6
2,000	343	.9	305	5.3	286	7.3	46	1.2	296	8.8	276	6.6	295	8.2	273	8.2	296	2.7	282	7.2	284	2.4	90	2.3
2,500	279	2.7	311	5.5	293	8.1	52	1.9	292	9.3	284	10.9	303	10.2	283	9.7	346	3.5	276	9.3	298	4.7	64	1.1
3,000	272	4.6	316	5.7	291	7.3	60	2.4	300	9.1	282	10.6	301	10.6	287	9.5	335	3.6	272	9.9	301	6.1	360	.9
4,000	266	6.8	307	4.8	277	6.4	43	1.4	302	8.7	272	6.7	------	------	297	8.0	309	4.6	259	8.0	306	8.5	346	2.2
5,000	264	5.7	------	------	------	------	59	1.4	------	------	252	2.3	------	------	------	------	279	5.0	255	7.0	300	8.9	------	------

Altitude (m) m. s. l.	Los Angeles, Calif. (217 m)		Medford, Oreg. (410 m)		Memphis, Tenn. (83 m)		New Orleans, La. (19 m)		Oakland, Calif. (8 m)		Oklahoma City, Okla. (402 m)		Omaha, Nebr. (306 m)		Phoenix, Ariz. (338 m)		Salt Lake City, Utah, (1,294 m)		Sault Ste. Marie, Mich. (198 m)		Seattle, Wash. (14 m)		Washington, D. C. (19 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
Surface	58	0.5	186	1.1	44	0.4	50	3.4	172	1.2	179	2.9	144	0.8	102	2.1	139	2.8	343	0.9	167	1.5	313	1.5
500	85	.5	200	.8	153	1.5	90	3.7	324	1.2	185	5.2	209	1.8	101	2.4	------	------	311	1.3	109	2.1	332	5.3
1,000	168	.8	162	.8	285	1.6	113	3.1	20	1.8	206	8.0	251	4.6	136	.7	------	------	305	8.5	214	2.1	329	6.9
1,500	139	1.2	165	2.5	202	3.2	96	1.9	1	2.5	237	5.7	272	5.2	180	1.3	157	3.8	302	9.7	194	3.1	317	7.7
2,000	221	1.9	202	3.9	298	3.7	39	2.8	339	1.8	256	4.7	279	7.1	192	2.7	174	3.8	307	7.7	209	3.7	297	10.3
2,500	228	2.1	216	5.3	319	5.0	18	2.9	312	1.9	257	4.4	286	8.5	215	3.4	210	2.9	317	7.3	212	4.1	297	10.1
3,000	238	2.7	223	5.2	304	3.9	16	2.8	250	1.6	260	5.3	283	8.1	227	4.9	234	3.8	314	5.6	202	4.4	309	10.8
4,000	266	3.0	250	3.1	337	.5	13	3.4	------	------	296	6.2	265	5.6	233	6.4	208	6.1	------	------	195	10.9	296	8.4
5,000	------	------	253	9.1	------	------	------	------	------	------	298	6.9	------	------	262	6.4	273	7.3	------	------	------	------	------	------

RIVERS AND FLOODS

By RICHMOND T. ZOCH

[River and Flood Division, MONTROSE W. HAYES, in charge]

There were a number of floods during the month, as shown in the table, but none of great importance, as the total reported damage was only $28,000. It is estimated that property to the value of $23,000 was saved as a result of Weather Bureau warnings.

Table of flood stages in October 1934

[All dates are in October]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC SLOPE DRAINAGE					
	Feet			*Feet*	
Saluda: Chappells, S. C.	12	11	13	16.1	12
Broad: Blairs, S. C.	14	11	13	26.2	12
Congaree: Columbia, S. C.	15	12	12	19.3	12
Santee:					
Rimini, S. C.	12	4	7	13.8	6
		10	22	18.0	16
		24	28	13.6	26
Ferguson, S. C.	12	14	23	13.8	17

Table of flood stages in October 1934—Continued

River and station	Flood stage	Above flood stages—dates		Chest	
		From—	To—	Stage	Date
ATLANTIC SLOPE DRAINAGE					
	Feet			*Feet*	
Broad: Carlton, Ga.	15	11	11	16.0	11
Savannah: Ellenton, S. C.	14	9	17	20.3	14
Ocmulgee:					
Macon, Ga.	18	12	12	18.9	12
Abbeville, Ga.	11	19	20	11.1	19
EAST GULF OF MEXICO DRAINAGE					
Coosa: Lock No. 4, Lincoln, Ala.	17	11	11	17.6	11
Cahaba: Centerville, Ala.	23	10	12	26.5	10
Black Warrior: Lock No. 10, Tuscaloosa, Ala.	46	10	13	57.6	11
Tombigbee: Lock No. 3, Ala.	33	14	19	36.8	17
PACIFIC SLOPE DRAINAGE					
Columbia Basin					
Santiam: Jefferson, Oreg.	10	24	24	10.05	24

WEATHER OF THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, W. F. McDONALD in charge]

NORTH ATLANTIC OCEAN

By H. C. HUNTER

Atmospheric pressure.—The pressure during October 1934 averaged somewhat greater than normal over the eastern portion of the North Atlantic Ocean to southward of the vicinity of Ireland, but decidedly below normal in the regions adjacent to Scotland and Iceland. The western half of the ocean had pressure lower than normal nearly everywhere save to southward of the 25th parallel of latitude. The pressure at Bermuda was comparatively low for a while just before the middle of the month, and again from the 20th to the 28th. Farther eastward the semipermanent anticyclone was well developed except at times during the final 10-day period.

The highest pressure reported by a vessel was 30.71 inches, by the *American Importer*, about latitude 50° N., longitude 29° W., during the forenoon of the 16th. The lowest reading was 28.49 inches, about 10 p. m. of the 21st, by the British steamship *Caledonia*, near 55° N., 14° W.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, October 1934*

Stations	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	29.72	----------	30.16	30	29.14	9
Reykjavik, Iceland	29.57	−0.11	30.51	15, 30	28.79	7
Lerwick, Shetland Islands	29.52	−.27	30.18	16	28.87	28
Valencia, Ireland	29.97	+.06	30.52	16	28.89	4
Lisbon, Portugal	30.13	+.11	30.39	6	29.94	23
Madeira	30.03	+.04	30.22	5, 6	29.64	31
Horta, Azores	30.17	+.06	30.40	17	29.46	24
Belle Isle, Newfoundland	29.84	−.03	30.28	24	28.94	8
Halifax, Nova Scotia	29.93	−.11	30.54	5	29.34	27, 28
Nantucket	29.96	−.09	30.47	5	29.42	26
Hatteras	30.04	−.02	30.32	17	29.65	27
Bermuda	29.98	−.09	30.18	29, 30	29.62	13, 24
Turks Island	29.95	.00	30.07	7	29.85	23, 24
Key West	29.96	+.02	30.19	30	29.78	13
New Orleans	30.03	.00	30.32	28	29.76	5

NOTE.—All data based on a. m. observations only, with departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.

Extra-tropical cyclones and gales.—An unusually large number of reports of gales encountered outside tropical waters have come to hand, but in only two instances was the force of the wind greater than Beaufort 10. The earlier case was late on the 1st, when the Norwegian motorship *Slemmestad*, bound from Copenhagen to Montreal, was about 300 miles northeast of the Straits of Belle Isle, and met force 12 from the west-southwest. A well-developed LOW was moving northeastward from Labrador to southern Greenland, but so far to the northwest that vessels along the chief steamship lanes were but little affected.

Four days later a well-marked storm was centered about midway between Labrador and the Shetland Islands (see chart VIII). Strong gales and low pressure readings were noted by many vessels in mid-Atlantic waters near or to northward of the fiftieth parallel. The center of this storm advanced to northeastward on the 6th and crossed Iceland the following day.

For almost a fortnight after the 6th no important gales were encountered in North Atlantic waters. On the 20th, however, a LOW had attained considerable strength to southeastward of New England and it increased in energy during the following days as it traveled eastward close to the chief steamship lanes. The second instance of force over 10 was connected with this storm; the American steamship *Syros*, from Galveston for Havre, noted storm wind (force 11) when near 49° N., 18° W. on the 24th. Shortly before it reached the British Isles, this LOW turned sharply to northward and on the 26th merged with another disturbance near Iceland.

On the forenoon of the 26th a cyclone that was, as yet, of comparatively small importance was centered near New York City, whence it moved first eastward with much increase of energy, then northward and later even to west of northward till near the northeastern corner of Hudson Bay. This storm caused widespread gales on the 26th and 27th in the area included between the coasts and lines drawn from Bermuda to Hatteras and to eastern Newfoundland. The situation on the 27th appears on chart IX. Several vessels close to Nova Scotia recorded pressures below 29 inches on that date.

Tropical storms.—Three interesting storms were noted within or comparatively close to tropical waters during the first week; none, however, seems to have attained great importance and in each of two cases only one vessel has furnished a report, so that small size and brief existence are probable.

The Dutch motorship *Selene*, about midnight of the 1st-2d, encountered a whole gale from the north, when near 29° N., 42° W. A period of calm ensued for about 50 minutes, the pressure being as low as 29.06 inches, then a southerly whole gale came, followed by lessening wind and rapid rise of barometer.

On the forenoon of the 2d pressure was moderately below normal at the Yucatan Channel; and a storm center traveled thence slowly northwestward into the Gulf of Mexico and later turned northeastward. The situation on the 5th appears on chart VIII. During the following night the center reached the coast line near Pensacola, Fla. No report concerning this storm shows great energy or marked damage, but several vessels encountered gales of forces 8 to 10.

About mid-day of the 7th, the French steamship *Eliane L. D.*, bound from Cape Verde Islands to Buenos Aires, encountered a vigorous but brief storm, with marked shift of wind, when in 9° N., 28° W. The lowest pressure noted was only 29.82 inches.

Fog.—Fog was mainly less frequent in occurrence during October than it had been during September, notably along the American coast from Hatteras to the Gulf of St. Lawrence, and eastward to include the region of the Grand Banks. There were, however, several 5° squares within which it was encountered on 5 or 6 days, most commonly about the middle of the month, when gales were notably infrequent.

From the fortieth meridian eastward to the vicinity of Ireland, there was somewhat more fog in October than there had been during the preceding month, although no area here has furnished reports of occurrence on more than 5 days. On the main steamship lanes near the twenty-fifth meridian there was more fog than is normally encountered in October in that locality.

OCEAN GALES AND STORMS, OCTOBER 1934

Vessel	Voyage		Position at time of lowest barometer		Gale began October—	Time of lowest barometer October—	Gale ended October—	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′				*Inches*					
Slemmestad, Nor. M. S.	Copenhagen	Montreal	55 24 N.	48 30 W.	1	11p, 1	2	28.72	S	WSW, 12	WNW	WSW, 12	S-WSW-WNW.
Leerdam, Du. S. S.	Rotterdam	New York	50 47 N.	22 00 W.	3	Noon, 3	4	29.01	W	WNW, 9	WNW	WNW, 9	W-WNW.
West Quechee, Am. S. S.	Galveston	Liverpool	49 25 N.	25 26 W.	2	1p, 3	3	29.59	NW	WNW, 9	WNW	WNW, 9	
City of Newport News, Am. S. S.	Havre	Norfolk	49 50 N.	19 15 W.	3	2p, 3	4	29.39	W	W, 9	W	W, 10	None.
Gulf of Mexico, Am. S. S.	New York	Port Arthur	28 35 N.	90 50 W.	3	4p, 3	3	29.78	NE	E, 5	NE	NE, 8	E-NE.
Garoet, Du. S. S.	Rotterdam	Tampa	46 59 N.	11 05 W.	4	4a, 4	4	29.31	WSW	W, 8	WNW	WNW, 8	W-WNW.
Clydefield, Br. M. S.	Curacao	Amsterdam	49 28 N.	6 24 W.	3	8a, 4	4	29.45	NW	WSW, 10	WNW	WSW, 10	WSW-W.
Nemaha, Am. S. S.	New Orleans	Tampa	28 40 N.	85 40 W.	4	4p, 5	5	29.65	ESE	SE, 9	SE	SE, 9	
Leerdam, Du. S. S.	Rotterdam	New York	49 50 N.	38 06 W.	5	11p, 5	6	28.80	N	S, 4	NW	NNW, 10	S-N.
Magmeric, Am. S. S.	Charleston	Liverpool	51 06 N.	14 44 W.	3	11a, 6	6	29.65	NW	SSW, 8	SSW	NW, 9	
Tennessee, Dan. S. S.	New York	Oslo	56 19 N.	26 24 W.	5	4p, 6	7	28.67	ENE	WSW, 7	WSW	W, 10	SW-WSW.
Eliane L. D., Fr. S. S.	Cape Verde Islands.	Buenos Aires	9 10 N.	27 48 W.	7	11a, 7	7	29.82	NE	ESE, 10	SSE	SE, 10	NE-SSE.
Myrtlebank, Br. M. S.	Algiers	Halifax	43 00 N.	57 45 W.	7	5p, 7	7	29.32	SSE	WSW, 9	WNW	SSW, 10	SSW-WSW-W.
Leerdam, Du. S. S.	Rotterdam	New York	47 30 N.	50 10 W.	7	1a, 8	8	29.03	SSE	SW, 10	WSW	S, 10	S-SW-WSW.
Tennessee, Dan. S. S.	New York	Oslo	58 16 N.	13 15 W.	8	Noon, 8	8	29.62	SSE	SSE, 9	W	WSW, 10	SSE-WSW.
Collamer, Am. S. S.	Havre	New York	48 26 N.	41 45 W.	8	2p, 8	8	29.61	S	SSW, 9	SW	SSW, 9	SSW-SW.
Mandu, Braz. S. S.	Bahia	do	28 55 N.	65 08 W.	12	3a, 12	12	29.65	S	S, 8	WSW	SSW, 9	S-SSW.
Quaker City, Am. S. S.	Boston	Liverpool	[1] 45 17 N.	58 41 W.	12	8p, 12	12	29.25	SE	SE, 8	ENE	SE, 8	SE-ENE.
Quistconck, Am. S. S.	Houston	Barcelona	39 54 N.	55 06 W.	12	7a, 13	13	29.36	SW	SW, 9	SW	S, 9	SSW-WSW.
Sarcoxie, Am. S. S.	Bordeaux	New York	48 34 N.	27 45 W.	20	4p, 20	20	29.36	NW	NW, 6	NW	NW, 8	SW-NW.
Scanstates, Am. S. S.	Copenhagen	do	58 16 N.	16 32 W.	21	8p, 21	22	28.53	N	SW, 2	NNW	N, 10	SW-N.
Caledonia, Br. S. S.	Glasgow	do	55 26 N.	14 17 W.	21	10p, 21	22	28.49	S	WSW, 9	WNW	SW, 9	SW-WSW.
Conte di Savoia, Ital. S. S.	Gibraltar	do	37 56 N.	46 24 W.	22	Mdt., 22	23	28.94	WSW	W, 9	W	W, 10	WSW-W.
Baarn, Du. S. S.	Curacao	Liverpool	47 40 N.	23 40 W.	24	2a, 24	24	29.17	NE	NE, 8	NNW	N, 8	
Syros, Am. S. S.	Galveston	Havre	49 13 N.	18 06 W.	24	10a, 24	25	28.82	ENE	NNE, 11	NW	NNE, 11	ENE-NNE.
Ivar, Dan. S. S.	Shields, England.	Montreal	58 00 N.	35 00 W.	23	4p, 24	26	29.49	SW	W, 10	W	W, 10	None.
E. J. Sadler, Am. S. S.	New York	Baytown, Texas.	28 42 N.	93 12 W.	25	6a, 25	25	29.98	NW	NW, 8	NW	NW, 9	
Lord Kelvin, Br. S. S.	[3]	[3]	50 04 N.	11 00 W.	24	6a, 25	25	29.03	S	SSW, 8	WNW	WNW, 9	S-SSW-W.
Markhor, Br. S. S.	Gibraltar	Boston	36 38 N.	19 53 W.	26	6a, 26	26	29.46	NE	NE, 7	N	NE, 10	SE-NE.
Maine, Dan. S. S.	Newcastle	Montreal	[1] 59 15 N.	14 38 W.	26	1p, 26	28	29.03	W	W, 9	NW	WNW, 10	Steady.
San Benito, Pan. S. S.	St. John, N. B.	Habana	38 29 N.	70 57 W.	26	4p, 26	27	29.54	NW	W, 4	SW	SW, 9	SSW-W-NW.
Katendrecht, Du. M. S.	Leixoes	Philadelphia	38 53 N.	67 15 W.	27	1a, 27	27	29.23	WNW	W, 7	WNW	NW, 9	S-W-NW.
Imlay, Am. S. S.	Carapita	Boston	33 51 N.	68 00 W.	27	1a, 27	28	29.54	W	W, 8	NW	NW, 9	W-NW.
Chester Valley, Am. S. S.	Gibraltar	Tampa	33 12 N.	20 52 W.	27	6a, 27	27	29.24	SW	WNW, 8	NNW	SW, 10	SW-WNW.
Victolite, Br. M. S.	Montreal	Cartagena	38 08 N.	65 11 W.	27	6a, 27	28	29.15	SW	SW, 7	W	W, 10	S-SW-W.
Caledonia, Br. S. S.	Glasgow	New York	42 20 N.	62 13 W.	27	5p, 27	27	28.88	NW	NW, 9	WSW	NW, 9	S-NW.
Scanstates, Am. S. S.	Copenhagen	do	43 31 N.	59 30 W.	27	8p, 27	28	28.80	W	SW, 3	W	W, 10	SW-W.
Exochorda, Am. S. S.	Gibraltar	Boston	[1] 42 46 N.	59 49 W.	27	10p, 27	29	28.89	SSW	SSW, 9	W	W, 9	SSW-W.
United States, Dan. S. S.	Oslo	Halifax	59 25 N.	3 25 W.	28	4a, 28	28	28.85	SW	SW, 8	NW	SW, 8	SW-NW.
Lord Kelvin, Br. S. S.	[3]	[3]	50 27 N.	10 44 W.	30	2p, 30	30	29.84	NNE	NNW, 6	NNW	NNW, 8	NNW-NNE.
NORTH PACIFIC OCEAN													
Manini, Am. S. S.	Bellingham	Honolulu	44 48 N.	131 54 W.	1	3p, 1	1	29.73	WNW	WSW, 6	NW	WNW, 10	SSE-NW.
Pres. Jefferson, Am. S. S.	Victoria, B. C.	Yokohama	51 50 N.	139 46 W.	1	3p, 1	1	29.73	SSW	SSW, 8	W	W, 8	SSW-W.
Skramstad, Nor. M. S.	Philippine Is.	Los Angeles	19 20 N.	132 30 E.	2	8a, 2	2	29.34	NNE	NNE, 7	SE	E, 11	NNE-SE.
Everett, Am. S. S.	Yokohama	Seattle	47 45 N.	162 43 E.	1	Noon, 2	3	28.15	SE	SW, 6	WNW	WNW, 11	S-W-WNW.
Shiraha Maru, Jap. S. S.	Miike, Japan	Olympia	49 35 N.	168 10 W.	3	Noon, 2	4	29.35	SW	SW, 6	W	WSW, 9	SSW-SW.
Golden Horn, Am. S. S.	San Francisco	Fushiki	46 53 N.	177 22 E.	2	4p, 2	4	29.12	SE	SSE, 8	NW	W, 10	SE-SSE-SW.
Norway Maru, Jap. S. S.	Port Alice	Yokohama	51 32 N.	164 22 W.	2	Noon, 3	4	29.28	S	SW, 11	NW	SW, 11	WSW-SW.
Pres. Jefferson, Am. S. S.	Victoria, B. C.	do	52 48 N.	157 18 W.	3	2a, 4	4	29.34	SW	WSW, 9	NNW	WSW, 9	WSW-SW.
Yoseric, Br. S. S.	Keelung	Wusung	26 45 N.	121 55 E.	4	10a, 4	4	29.96	NNE	NE, 7	NNE	NNE, 8	NE-NNE.
City of Bagdad, Br. S. S.	Singapore	Hong Kong	[1] 17 43 N.	113 36 E.	4	4a, 4	8	29.88	NNE	NE, 5	NE	NE, 8	NE-NNE.
Tascalusa, Br. S. S.	Yokohama	Los Angeles	41 38 N.	158 26 E.	4	10p, 4	4	29.38	E	SSW, 7	SSE	E, 8	SSE-SSW.
Zuiyo Maru, Jap. S. S.	Los Angeles	Sasebo	41 00 N.	164 30 E.	5	3a, 5	5	29.70	S	W, 11	WNW	W, 11	SSW-W.
Tyndareus, Br. S. S.	Yokohama	Vancouver, B. C.	50 00 N.	140 42 W.	5	3a, 5	5	29.38	SE	S, 9	S	S, 9	SE-S.
Hokuroku Maru, Jap. M. S.	do	Los Angeles	46 56 N.	173 55 W.	5	2p, 5	6	28.92	SE	SSE, 4	NW	N, 10	SSE-NW.
San Diego Maru, Jap. M. S.	do	do	43 20 N.	142 00 W.	6	5a, 7	8	28.92	SE	SSW, 8	SSW	WSW, 10	SW-SSW-SW.
Empress of Japan, Br. S. S.	Honolulu	Vancouver, B. C.	37 52 N.	141 44 W.	6	6a, 7	8	29.62	SW	WSW, 7	S	W, 9	SW-WSW-W.
Golden Star, Am. S. S.	San Francisco	Yokohama	46 40 N.	150 30 W.	6	7a, 7	8	28.46	ESE	SE, 4	NW	NW, 9	SSW-SE-N.
Skramstad, Nor. M. S.	Philippine Is.	Los Angeles	28 00 N.	149 30 E.	7	9p, 7	8	28.80	E	SW, 12	SW	SW, 12	E-SW.
HokurokuMaru,Jap.M.S.	Yokohama	do	43 30 N.	154 48 W.	8	2a, 8	8	28.95	WSW	SW, 9	SW	SSW, 10	W-SW.
Shiraha Maru, Jap. S. S.	Miike, Japan	Olympia	50 24 N.	137 52 W.	8	3a, 8	8	28.67		SW, 8		SW, 8	
Tascalusa, Br. S. S.	Yokohama	Los Angeles	[1] 45 04 N.	163 41 W.	9	4p, 11	10	28.96	E	SSW, 6	ESE	E, 8	Steady.
Golden Hind, Am. S. S.	Dairen	Portland, Oreg.	50 30 N.	173 46 W.	10	Mdt, 10	11	29.41	NE	NE, 8	N	NE, 9	NE-N-NE.
Golden Star, Am. S. S.	San Francisco	Yokohama	48 09 N.	169 00 W.	10	10a, 11	12	28.89	E	E, 3	NNW	N, 11	SSE-E-N.
Silverguava, Br. M. S.	Legaspi, P. I.	Portland, Oreg.	49 07 N.	148 01 W.	11	2a, 12	12	29.45	SE	S, 9	S	S, 10	SE-S.
Chichibu Maru,Jap.M.S.	Yokohama	Honolulu	34 57 N.	144 06 E.	11	10a, 12	12	28.51	NE	N, 12	NNW	N, 12	NNE-N-NNW.
Hakutatsu Maru, Jap. S. S.	Miike, Japan	Vancouver	38 28 N.	146 33 E.	12	6p, 12	12	29.24	SE	N, 9	NNW	N, 9	ENE-N-NNW.
San Luis Maru, Jap. M. S.	Estero Bay, Calif.	Yokohama	34 39 N.	154 00 E.	12	8p, 12	12	29.47	SE	S, 9	WSW	S, 9	SSE-S-WSW.
Golden Star, Am. S. S.	San Francisco	do	45 49 N.	176 30 W.	13	Noon, 13	13	29.74	S	SSW, 5	S	S, 8	S-SSW-W.
El Mirlo, Br. M. S.		Los Angeles	16 04 N.	106 27 W.	13	3p, 15	15	[2] 29.47	W	W, 10	W	W, 10	WSW-W.
Meigs, U. S. A. T.	Manila	San Francisco	14 03 N.	125 52 E.	15	8a, 15	16	29.45	ENE	ENE, 8	SE	SE, 8	NNE-ENE-SE.
Frank G. Drum, Am. S. S.	Balboa	Los Angeles	[1] 18 54 N.	106 01 W.	16	1a, 16	16	29.14	ESE	W, 12	SW	W, 12	ENE-W.
California, Am. S. S.	Los Angeles	Balboa	20 00 N.	105 45 W.	15	2a, 16	16	29.14	ESE	N, 10	W	NNW, 10	NNE-N-NNW.
Cathwood, Am. S. S.	do	do	19 35 N.	106 00 W.	15	3a, 16	16	[2] 28.73	NE	N, 12	S	N, 12	NE-N-W.
San Jose, Fr. S. S.	do	do	19 48 N.	106 26 W.	15	3a, 16	16	29.07	N	N, 12	S	N, 12	N-WNW.
Californian, Am. M. S.	do	do	19 14 N.	105 10 W.	15	3a, 16	16	29.36	ESE	SSE, 12	SSW	SSE, 12	ESE-SSE-S.
Maine, Am. S. S.	do	do	19 00 N.	105 00 W.	15	4a, 16	16	29.43	SE	SSE, 12	SW	SSE, 12	SSE-S-SW.
Dryden, Am. S. S.	Balboa	Los Angeles	19 40 N.	105 48 W.	15	4a, 16	16	28.25	E	NNE, 12	W	NNE, 12	E-NNE-NW
Pukkastan, Br. S. S.	Vancouver, B. C.	Balboa	20 00 N.	106 43 W.	15	5a, 16	16	29.62	NW	—, 10		—, 10	
Talamanca, Am. S. S.	San Francisco	do	20 36 N.	107 00 W.	16	5a, 16	16	29.56	N	N, 5	S	W, 7	N-NNW-W.

[1] Position approximate.
[2] Barometer uncorrected.
[3] At cable grounds near Valencia.

OCEAN GALES AND STORMS, OCTOBER 1934—Continued

Vessel	Voyage		Position at time of lowest barometer		Gale began October—	Time of lowest barometer October—	Gale ended October—	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH PACIFIC OCEAN—Con.			° ′	° ′				Inches					
San Bernardino, Am. S. S.	Balboa	San Diego	13 42 N.	91 30 W.	18	6a, 17	18	29.81	N	WNW, 2	N	N, 8	WNW-NW.
Pres. Jackson, Am. S. S.	Victoria, B. C.	Yokohama	52 08 N.	156 01 W.	16	8a, 17	17	29.52	SSW	WSW, 8	W	WSW, 9	SW-WSW-W.
Mana, Am. S. S.	Seattle	Honolulu	42 40 N.	135 22 W.	20	4p, 20	21	29.21	SE	NW, 10	NW	NW, 10	SE-NW.
Empress of Japan, Br. S. S.	Vancouver, B. C.	do	46 42 N.	128 15 W.	21	6a, 21	21	28.93	NE	NNE, 8	WNW	NNW, 10	E-NNE-NW.
Steel Inventor, Am. S. S.	Victorias, P. I.	do	18 10 N.	143 28 E.	22	Mdt, 22	23	29.10	NNE	SW, 12	SE	N, 12	N-WNW-S.
Atlantic City, Br. S. S.	Dairen	Los Angeles	41 38 N.	142 50 E.	24	2a, 25	26	29.60	SW	WSW, 8	WNW	WSW, 8	SW-WSW-WNW.
Golden Star, Am. S. S.	San Francisco	Yokohama	35 21 N.	141 45 E.	24	4a, 25	25	29.80	SSE	S, 8	S	S, 8	S-SW.
Sanyo Maru, Jap. M. S.	Yokohama	Los Angeles	41 35 N.	138 53 W.	27	Noon, 27	28	29.49	ESE	ESE, 8	SSE	SSE, 9	
Teiyo Maru, Jap. M. S.	do	do	40 20 N.	142 20 W.	27	3p, 27	27	29.19	SSW	SSW, 7	S	S, 8	E-SSW.
Pres. Garfield, Am. S. S.	San Francisco	Honolulu	34 14 N.	132 53 W.	28	Noon, 28	28	29.72	SSE	SSE, 8	W	SSE, 8	SSE-W.
Bellingham, Am. S. S.	Dairen	Seattle	50 18 N.	141 26 W.	28	4p, 28	28	28.82	E	SE, 9	SE	SE, 9	None.
Iowa, Am. S. S.	Yokohama	San Francisco	47 36 N.	157 54 W.	28	2a, 29	31	29.38	NW	NW, 9	WNW	NW, 10	None.
Atlantic City, Br. S. S.	Dairen	Los Angeles	42 30 N.	161 15 E.	28	4a, 29	30	29.37	SSE	S, 10	NW	S, 10	SSE-S-WSW.
San Julian, Am. S. S.	Yokohama	do	46 00 N.	160 24 W.	30	2a, 30	31	29.41	W	NW, 7	W	W, 9	NW-W.

NORTH PACIFIC OCEAN, OCTOBER 1934

By WILLIS E. HURD

Atmospheric pressure.—Over all of the northeastern part of the North Pacific Ocean—from Bering Sea to the coast of Washington—pressures were below normal, with the average October barometer at Kodiak (29.33 inches) showing a minus departure of a quarter inch. At or near Kodiak lay the average center for the month of the Aleutian LOW, which this early in the season had developed an intensity equal to that characteristic of the height of the winter season.

In middle and low latitudes pressures were about normal or somewhat above, with the extreme plus departure of 0.08 noted at Midway Island. Both the Aleutian LOW and the mid-Pacific HIGH, therefore, were abnormally well developed for the season.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, October 1934, at selected stations*

Station	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	Inch	Inches		Inches	
Point Barrow	29.76	−0.17	30.16	22	29.18	17
Dutch Harbor	29.63	−.02	30.16	26	28.78	30
St. Paul	29.57	−.06	30.16	26	28.58	3
Kodiak	29.33	−.26	30.28	14	28.74	31
Juneau	29.76	−.11	30.35	26	29.01	8
Tatoosh Island	29.97	−.04	30.40	13	28.85	21
San Francisco	30.02	+.01	30.30	23	29.66	16
Mazatlan	29.88	+.04	29.98	31	29.74	15
Honolulu	30.01	.00	30.13	3	29.79	14
Midway Island	30.11	+.08	30.24	3	29.98	19
Guam	29.88	+.04	29.98	2	29.74	15
Manila	29.79	−.01	29.92	28, 29	29.16	15
Hong Kong	29.95		30.10	25, 29	29.69	1
Naha	29.98	+.08	30.12	17, 28, 29	29.82	7, 9, 10
Chichishima	29.94	+.03	30.20	15	29.58	26
Nemuro	30.13		30.52	22	29.80	14

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observation.

Cyclones and gales.—From the beginning to the end of October a succession of cyclonic storms occurred along the upper steamship tracks. These cyclones as a rule were of most pronounced energy during the first third of the month; and the lowest reported barometer was on the 2d, when the American S. S. *Everett* observed a reading of 28.15 inches, with gales up to force 11 on both the 2d and 3d, in the vicinity of 48° N., 163° E. Winds on these dates were also severe (of force 10–11) along other portions of the upper routes between 160° E. and 160° W. Other winds of force 11 occurred on the 5th and 11th over limited areas north of the 40th parallel, between the meridians already mentioned, as well as gales of less force on other days.

Anticyclones affected northern waters of the Pacific on only 2 or 3 days of the month; and the rise to 30 inches or higher in pressure, when it did occur, was of only a few hours' duration. The prevailing weather, therefore, was for the most part that which might be expected from a succession of disturbances, several below 29 inches in depth, occurring in the midst of a region of generally shallow pressure. This was specifically the case in higher latitudes between the 180th meridian and longitudes 130° to 135° W. In this region gales were reported on at least two-thirds of the days of the month. Pressure fell to well below 28.75 inches on the 6th to 8th and 28th to 30th, about midway between the eastern Aleutians and the coast of Oregon, with attendant gales.

The extratropical cyclone of the month which is outstanding because of its local severity and resulting coastal damage, was that of October 21. This originated on the 20th, near 43° N., 135° W., as a secondary LOW in the southeastern quadrant of a major storm central in Alaskan waters. During the night of the 20th–21st this depression moved northeastward with fast-gathering intensity, and on the early morning of the 21st was lashing the coasts of Washington and Oregon; the British S. S. *Empress of Japan*, in 46°42′ N., 128°15′ W., at 5:30 a. m. had a pressure reading of 28.93 inches, followed at 9 a. m. by a north-northwest gale of force 10. During the day the barometer fell to 28.85 inches at Tatoosh Island, and the wind rose to a velocity of 87 miles an hour at North Head, Wash. Huge waves, 20 or more feet in height, rose even in the inland waters of Puget Sound and Lake Washington.

From the marine standpoint, damage was heavy to docks, piers, and small craft, especially in the Washington and northern Oregon areas. Among the marine casualties, may be mentioned the S. S. *Floridian*, which after leaving Portland, was damaged by heavy weather a few miles outside the mouth of the Columbia River, and was forced to return to port for repairs. The S. S. *President Madison*, anchored at Seattle on the 21st, was torn from her moorings in the gale and, crashing into the S. S. *Harvester*, sunk the latter ship, though not before her crew escaped to safety.

In addition to a property loss amounting to more than a million dollars, 22 persons perished, as a result of the

storm, which was one of the severest ever known on that coast.

A note of considerable interest in connection with this storm is the report that Tillamook Rock Light, 133 feet above the ocean, was extinguished for the first time in its history by the seas that swept over its top during the height of the gale.

Hurricane off the Mexican West Coast.—One severe tropical cyclone occurred this month west of Mexico. Unlike the hurricane of the preceding September, which traversed a long stretch of coastline, this storm apparently originated at some distance from the coast, and moved northward toward the Gulf of California. The northbound British M. S. *El Mirlo* ran into the moderate west gales of the cyclone at 4 p. m. of the 14th, in 14° N., 105° W. With the storm center moving ahead of her, the ship continued in westerly gales for 24 hours, the maximum wind-force being W., 10, at 3 p. m. of the 15th, in 16°04′ N., 106°27′ W. On the morning of the 16th the hurricane center was definitely located near 19°40′ N., 105°50′ W., where the U. S. S. *Dryden*, in a north-northeast hurricane, had a barometer reading of 28.25 inches. Several other ships during the early hours of the 16th encountered hurricane velocities between 19°–20° N., 105°–107° W. The American S. S. *Maine* reported on the unusual suddenness of the onset and ending of the gale. The S. S. *Frank G. Drum*, hove to in the worst of the storm, reported the barometer as pumping violently. All reports indicate that by noon of the 16th gale winds had ceased, as the storm center apparently filled in with extraordinary rapidity.

Typhoons.—In the accompanying article, Typhoons in the Far East, by the Rev. Father Doucette, S. J., of the Manila observatory, five typhoons are indicated as having occurred in the Far East during October. Of these, 3 affected the Philippines; and 2, originating east of the Marianas, moved west-northwest to 20° N., 133°–134° E., then recurved to north and northeast, and passed seaward at some distance east of the Japanese Islands.

It is evident that each of these storms attained great force along some portion of its path. Scattered ship reports show that, in the typhoon of September 29–October 11, the Norwegian M. S. *Skramstad* experienced an east gale of force 11, barometer 29.34, on the 2d, in 19°20′ N., 132°30′ E.

In the typhoon of October 6–12 the Japanese M. S. *Chichibu Maru* reported a north wind of hurricane violence, lowest barometer 28.51, on the 12th, near 35° N., 144° E. This is close to the last day's position of the typhoon center, as given in the Manila report, while the storm actually proceeded much farther to the northeastward on the 13th, according to the Tokyo weather maps.

The typhoon of October 21–28—the fifth mentioned in the subjoined Manila report—early became of hurricane violence, as indicated by the report of the American S. S. *Steel Inventor*, which encountered north and southwest winds of force 12, barometer 29.10 inches, in 18°10′ N., 143°28′ E., on the 22d. This storm also seems to have progressed considerably farther north and east than is noted in Fr. Doucette's table, as a storm report of the 29th, giving a south gale of force 10 near 43° N., 161° E., appears to be definitely associated with this storm in its final stages.

Finally, there is considerable evidence that a sixth typhoon should be added to the list for the month: On the 7th the Norwegian M. S. *Skramstad* encountered a second violent cyclone after leaving the Philippines en route to San Pedro, the earlier being that of the 2d. The second storm was in 28° N., 149½° E., wind southwest 12, lowest pressure 28.8 inches. This locality is several hundred miles northeast of the charted position of the only other typhoon of the date east of the Philippines. Unfortunately, there are no further data available to make certain the later history of this storm, although it may be the same cyclone depicted on the Japanese weather map of October 8, central near 33° N., 145° E.

Miscellaneous gales.—Moderate to fresh northers blew near or in the Gulf of Tehuantepec on the 16th and 18th.

Off the China coast the northeast monsoon was strong on the 3d to 9th, at times attaining fresh gale force in the neighborhood of the Taiwan Channel.

Fog.—Fog was less frequent in October, as a rule, than in the preceding month. Along the American coast it occurred on 4 days off Lower California; on 11 days off California; and on 3 days off the coast northward to Vancouver. Scattered fogs occurred in northern waters of the Pacific, being most frequent over the area lying between 30°–45° N., 160°–175° E., where it was reported on 8 days.

North Pacific aviation.—The flight of Sir Charles Kingsford-Smith from Australia to California in his plane, *Lady Southern Cross*, occurred partly in October. After his arrival at Suva, Fiji, on the 20th, he was delayed until the 28th in leaving for Honolulu, owing to unfavorable weather. On that date he left Suva and without material difficulty arrived at Honolulu about 24 hours later. On November 3 he left Honolulu, and arrived at Oakland, Calif., 15 hours later (Nov. 4). A few hundred miles from the California coast he encountered fog, but succeeded in locating his position, as he stated it, "by sighting the tops of the hills sticking out of the fog."

This is the first Australia-to-California flight.

THUNDERSTORMS AT SEA

The American S. S. *Point Caleta*, G. Hagsberg, master while in 16°20′ N., 99°58′ W., en route northward along the Mexican coast, passed through an electrical storm of "remarkable violence", during the night of October 2–3, 1934, according to a report furnished by the observer, Second Officer James R. Pace. Blinding flashes of lighting repeatedly struck the ship, causing the antenna to fall across the bridge. The fore and main topmasts were shattered, and the main truck was carried away. "Stays carried away the electric charge, and with the exception of when the antenna fell, there was little evidence of St. Elmo's fire."

On the early morning of October 4, in 18°31′ N., 104°15′ W., the S. S. *Point Caleta* passed through another "electrical disturbance of greater brilliancy than the previous night's storm. It began with squalls of wind and rain at 2 a. m. and ended at 3:10 a. m." Lightning this time did not strike the ship, but was striking at varying distances about it.

The barometer was steady on both occasions, and the wind was mostly light and variable.—W. E. H.

TYPHOONS IN THE FAR EAST, OCTOBER 1934

BERNARD F. DOUCETTE, S. J.

[Manila Observatory]

Five typhoons affected the weather of the Far East during October 1934. Three of these typhoons formed between Guam and Palau, moved northwest, crossed the Philippines and the China Sea, and entered Indo-China and China. The other two formed east of the northern Ladrone Islands, moved northwest or west-northwest, then recurved to the northeast and moved past Japan.

The approximate positions of these typhoons as they appeared on the 6 a. m. weather maps are given below.

Typhoon, Sept. 29 to Oct. 11

	Latitude (° N.)	Longitude (° E.)
Sept. 29	10	146
Sept. 30	12. 30	142. 30
Oct. 1	14	140
Oct. 2	17. 40	134. 30
Oct. 3	18	128. 20
Oct. 4	18	122
Oct. 5	18	118
Oct. 6	18	115
Oct. 7	18	114
Oct. 8	18	112
Oct. 9	18	111
Oct. 10	20	111
Oct. 11	22	112

This typhoon crossed northern Luzon October 4. Barometric minima reported are as follows: Tuguegararo, 733.60 mm (28.882 in.); Aparri, 740.03 mm (29.135 in.); Vigan, 740.32 mm (29.147 in.); Laoag, 739.80 mm (29.126 in.). Considerable loss of property was reported, but the destruction caused by this typhoon must be considered in conjunction with the effects of the previous typhoon that passed over almost the same path. It is to be noted that these two typhoons were very similar, both in their courses, velocity of travel, and intensity. The loss of life was reported, on October 9, to have been 39, most of these casualties being due to drowning.

Typhoon, Oct. 6 to 12

	Latitude (° N.)	Longitude (° E.)
Oct. 6	19	149
Oct. 7	18	140
Oct. 8	20	133
Oct. 9	20	133
Oct. 10	23	132
Oct. 11	27	136
Oct. 12	33	143

These locations of the center were found with the help of observations sent to the observatory by the captains of S. S. *Iowa*, S. S. *Michigan*, and S. S. *Steel Scientist*. This typhoon was of large area, intense, and moving slowly in the region of recurvature.

Typhoon, Oct. 13 to 19

	Latitude (° N.)	Longitude (° E.)
Oct. 13, 2 p. m	7	137
Oct. 14, 6 a. m	8. 30	134. 30
Oct. 15, 6 a. m	13	126. 30
Oct. 16, 6 a. m	15	120. 30
Oct. 17, 6 a. m	16	116
Oct. 18, 6 a. m	16	113
Oct. 19, 6 a. m	17	109

This typhoon was of small extent, moving very rapidly. It passed close to and north of Manila, October 16, 4 to 7 a. m.; 740 mm (29.134 in.) was the barometric minimum recorded at the observatory. The highest wind velocity recorded (1 minute average) was 57 m.p.h. on a 3-cup Robinson anemometer. At Infanta, Tayabas Province (about 40 miles east-northeast of Manila) the barometric minimum reported was 729.36 mm (28.715 in.), with gales of force 12. The eye of the storm passed over Infanta, an experience which the city of Manila did not have. The path of destruction was narrow. The property loss, consisting of crops ruined by inundation, roads and buildings destroyed, is estimated to have been about 9,000,000 pesos. This, with the report that 68 lives were lost, was published in the newspapers October 20.

The position of the observatory as the typhoon passed was a short distance south of the vortex. The writer, interested in the existence or nonexistence of fronts near the center of a typhoon, did not observe any discontinuity which could be called a front, as the typhoon passed.

Typhoon, Oct. 17 to 25

	Latitude (° N.)	Longitude (° E.)
Oct. 17	9	140
Oct. 18	10. 30	135
Oct. 19	13	128
Oct. 20	13. 30	123. 30
Oct. 21	14	119
Oct. 22	16	114
Oct. 23	16	111
Oct. 24	16. 30	108
Oct. 25	17	106

This typhoon passed south of Manila, October 20. It passed over Naga, Camarines Sur, and close to Batangas, Batangas Province. At Naga the barometric minimum was 738.01 mm (29.055 in.), with winds of force 9; at Batangas, 740.47 mm (29.153 in.), with winds of force 7, were recorded. The destruction was that due to heavy rains, namely loss of crops and animals, together with the ruin of light-material buildings. There were 22 lives lost. On October 25, in Indo-China, this typhoon caused the death of over 250 people, together with considerable property loss, including crops, buildings, and animals, according to the report in an Associated Press dispatch.

Typhoon Oct. 21 to 28

	Latitude (° N.)	Longitude (° E.)
Oct. 21	16	150 (2 p. m.)
Oct. 22	16. 30	147
Oct. 23	18	141
Oct. 24	19. 30	135
Oct. 25	20	134
Oct. 26	26	136
Oct. 27	28	139
Oct. 28	35	148

This typhoon was located with the help of observations from the S. S. *Steel Inventor* and the S. S. *Larry Doheny*, sent to the observatory, October 22 and 23. On the morning of the 24th, the S. S. *Larry Doheny* sent out a distress signal, the ship being almost helpless because of damage suffered in the typhoon. Because of the rapid movement of the typhoon, the destructive winds did not last long, and the ship was able to proceed to Guam under its own power, accompanied by the U. S. S. *Gold Star*.

In conclusion, the writer wishes to call attention to the 4 typhoons, 1 late in September, and the 3 in October, which crossed the Philippines. The first two were very similar in their courses and intensity. The third and fourth were similar, and moved along a course parallel to that of the first two, but displaced to the south. A satisfactory explanation of this regularity cannot be given until a more thorough study of these situations has been made. All that can be said now is that the anticyclones which formed over China during October were very important factors in the courses of these typhoons.

CLIMATOLOGICAL TABLES

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, October 1934

[For description of tables and charts, see Review, January, p. 37]

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	67.1	+2.5	Evergreen	92	8	4 stations	31	29	6.45	+3.66	Gadsden	12.38	Tuscumbia	1.52
Arizona	65.1	+1.6	Mohawk	110	[1] 2	Williams	12	24	.69	−.69	Portal	.84	54 stations	.00
Arkansas	66.2	+3.6	Okay	96	23	Dutton	25	28	.79	−2.30	Marianna	2.05	3 stations	.00
California	60.7	+.2	El Centro	112	1	2 stations	12	[1] 16	1.95	+.72	Upper Mattole	12.95	2 stations	.00
Colorado	52.0	+5.4	Holly	96	7	do	7	[1] 23	.10	−1.08	Springfield	.75	26 stations	.00
Florida	75.3	+2.2	Clermont	97	1	3 stations	35	29	3.64	−.63	Pensacola	20.51	Avon Park	.11
Georgia	66.8	+1.9	3 stations	93	[1] 1	Clayton	26	28	4.21	+1.50	Cornelia	9.27	Thomasville	.75
Idaho	49.8	+2.9	Lapwai	98	11	Obsidian	13	23	1.87	+.47	Wallace	7.24	Grand View	.17
Illinois	58.3	+3.3	Harrisburg	89	23	Aurora	23	30	1.66	−1.09	Anna	3.54	Danville	.48
Indiana	56.8	+2.1	Edwardsport	90	10	Marengo	20	28	.53	−2.21	Whiting	2.56	2 stations	T
Iowa	56.6	+5.1	2 stations	92	8	Humboldt	18	28	1.52	−.86	Clarinda	2.81	Grundy Center	.35
Kansas	62.3	+5.3	Hoxie	97	7	2 stations	21	28	1.29	−.66	Sedan	8.86	3 stations	.04
Kentucky	59.5	+1.3	2 stations	88	[1] 11	do	22	29	.88	−1.84	Middlesboro	3.39	Grant	.02
Louisiana	72.4	+4.1	Dodson	97	13	Tallulah	37	29	2.19	−1.11	Port Eads	11.71	Plain Dealing	.00
Maryland-Delaware	54.7	−1.5	Cambridge, Md	85	11	2 stations	15	14	1.35	−1.53	Milford, Del	2.47	Laurel, Md	.50
Michigan	49.5	+.5	Bangor	89	4	Roscommon, No. 2	10	19	1.97	−.76	Bessemer	3.65	Grand Marais	.47
Minnesota	50.4	+4.0	5 stations	88	[1] 11	5 stations	17	[1] 29	2.60	+.64	Minneapolis-W. B.	5.64	Winnebago	.73
Mississippi	68.7	+3.4	2 stations	93	2	Hernando	32	28	2.60	−.03	Columbia	7.06	Rosedale	.24
Missouri	61.1	+3.7	Tarkio	90	8	2 stations	24	28	2.45	−.40	Stover	5.51	Linneus	.65
Montana	48.5	+4.0	Savage	91	11	Circle (near)	3	31	1.14	+.11	Trout Creek (near)	6.02	5 stations	.00
Nebraska	57.3	+6.1	Purdum	97	7	2 stations	15	29	.91	−.70	Nebraska City	4.08	do	.00
Nevada	54.4	+4.1	Logandale	102	1	Canyon Creek Ranch.	9	23	.82	+.26	Lewers Ranch	3.53	Las Vegas	.00
New England	46.7	−2.8	2 stations	79	[1] 3	3 stations	19	[1] 10	2.66	−.90	Falmouth, Mass	5.31	Northfield, Vt	1.19
New Jersey	52.6	−2.1	Burlington	82	15	Runyon	21	30	2.49	−.92	Chatham	3.43	2 stations	1.48
New Mexico	57.0	+3.3	Carlsbad	101	5	Gavilan (near)	8	24	.55	−.61	Glenrio	3.16	8 stations	.00
New York	47.5	−2.4	4 stations	80	[1] 11	2 stations	14	14	2.48	−.81	Setauket	5.38	Binghamton	1.10
North Carolina	59.8	−.1	Rockingham	90	21	Mount Mitchell	14	28	2.43	−.93	Mount Mitchell	7.11	Edenton	.15
North Dakota	49.0	+5.5	Mayville	94	14	2 stations	5	[1] 29	1.01	−.03	Valley City	4.39	3 stations	.00
Ohio	54.3	+.9	Circleville	87	9	3 stations	20	[1] 14	.59	−1.97	Willoughby	1.92	Cambridge	T
Oklahoma	66.1	+3.8	Hugo	97	11	Woodward	27	28	1.33	−1.67	Norman	4.63	2 stations	.00
Oregon	51.7	+2.1	2 stations	98	10	Fremont	6	16	3.29	+1.37	Seaside	12.98	do	.26
Pennsylvania	51.8	−.6	do	84	9	Corry	11	20	1.46	−1.80	Renovo	3.15	Sharon	.51
South Carolina	63.6	.0	Blackville	91	22	2 stations	27	[1] 28	3.63	+.60	Crescent	8.21	Marion	.77
South Dakota	53.8	+5.3	2 stations	95	7	Lemmon	11	31	1.27	−.04	Murdo	3.35	Strool	T
Tennessee	61.5	+1.9	Moscow	90	[1] 22	2 stations	22	[1] 28	2.38	−.45	Parksville	5.74	Carthage	.76
Texas	72.6	+5.0	McCamey	102	5	Miami	27	28	.42	−2.34	Pierce	2.84	23 stations	.00
Utah	52.4	+3.5	St. George	96	6	Great Basin Expt. Station (Alpine).	9	23	.58	−.51	High Line City Creek.	2.55	5 stations	.00
Virginia	56.8	−.5	Stuart	91	19	2 stations	19	[1] 15	1.54	−1.40	Saltville	4.05	Cape Henry	.17
Washington	51.6	+1.5	3 stations	93	10	Bumping Lake	21	16	5.07	+2.11	Cedar Lake	16.58	2 stations	.69
West Virginia	54.4	−.2	Lost Creek	86	9	2 stations	14	[1] 14	1.01	−1.77	Union	3.34	Dam No. 19 O. R.	.10
Wisconsin	50.8	+2.6	Portage	85	11	Coddington	16	30	2.31	−.16	Superior	5.18	Wisconsin Dells	.66
Wyoming	48.7	+5.3	2 stations	91	7	South Pass City	−2	24	.79	−.33	Bechler River	4.41	8 stations	.00
Alaska (September)	46.7	+2.3	Seclusion Harbor	79	3	McKinley Park	12	17	2.61	−.97	Seward	12.15	Barrow	.01
Hawaii	74.8	+1.3	Kaneohe (Mauka)	93	17	Kanalohuluhulu	48	12	6.35	+.59	Hakalau (Mauka)	22.65	Olowalu	.03
Puerto Rico	78.1	.0	San German	97	26	Guineo Reservoir	49	6	5.80	−2.41	Lares	14.82	Santa Rita	1.91

[1] Other dates also.

TABLE 1.—*Climatological data for weather bureau stations, October 1934*

(Compiled by Annie E. Small)

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max.+mean min.÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with .01 or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	° *F.*	° *F.*	°*F.*		°*F.*	°*F.*		°*F.*	°*F.*	°*F.*	°*F.*	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
New England							48.7	−2.4										74	2.54	−0.7										5.7		
Eastport	76	67	85	29.86	29.94	−0.06	45.9	−1.6	63	7	52	32	29	40	18	42	39	78	2.64	−0.9	11	8,599	n.	34	ne.	13	7	10	14	6.5	0.0	0.0
Greenville, Maine	1,070	6	40	28.80	29.98	.....	41.1	.....	63	17	49	24	2	33	35	.....	.....	.....	1.95	.....	11	4,907	nw.	22	.....	7	8	4	19	.....	10.6	.....
Portland, Maine	103	82	117	29.86	29.98	−.06	47.8	−2.1	71	18	55	30	20	41	24	42	37	71	2.31	−.8	9	7,045	n.	27	n.	12	18	5	8	4.2	T	0
Concord	289	60	.....	.....	.....	.....	46.8	−2.9	72	3	57	28	31	37	39	.....	.....	.....	2.00	−.8	8	.....	nw.	.....	.....	.....	11	12	8	.....	.5	.0
Burlington	403	11	48	29.56	30.01	−.03	44.8	−4.4	65	25	52	28	28	38	28	.....	.....	.....	1.65	−1.3	11	7,614	s.	27	s.	17	10	4	17	6.4	T	.0
Northfield	876	12	60	29.06	30.03	−.01	42.9	−2.6	68	17	52	25	10	33	40	38	34	79	1.19	−1.7	12	5,778	n.	28	sw.	29	9	6	16	6.3	2.1	.0
Boston	124	336	360	29.86	30.00	−.05	49.6	−4.0	71	18	56	32	13	43	22	44	40	73	2.94	−.2	9	11,136	w.	43	w.	7	11	9	11	5.4	T	.0
Nantucket	12	14	90	29.96	29.96	−.09	52.6	−1.6	69	6	57	38	13	48	17	48	44	77	4.89	+1.5	14	12,049	n.	45	n.	13	6	7	18	6.8	T	.0
Block Island	26	11	46	29.96	29.99	−.06	52.8	−2.1	68	6	58	38	13	48	16	49	45	76	3.09	−.5	13	13,504	n.	47	w.	28	9	9	13	5.7	T	.0
Providence	160	215	251	29.82	30.00	−.05	50.4	−1.8	73	3	58	34	13	42	30	45	39	70	2.26	−.9	11	8,428	nw.	38	nw.	28	14	9	8	4.5	T	.0
Hartford	159	70	104	.....	30.03	−.03	50.1	−1.1	74	3	59	35	21	42	34	.....	.....	.....	2.42	−1.1	8	6,112	n.	.....	.....	.....	13	7	11	.....	T	.0
New Haven	106	74	153	29.91	30.03	−.03	51.6	−2.2	74	11	60	36	30	43	28	45	39	68	2.51	−1.2	8	7,012	n.	32	sw.	29	12	8	11	5.2	T	.0
Middle Atlantic States							54.8	−1.5										71	1.35	−1.7										4.7		
Albany	97	107	115	29.93	30.04	−.02	48.8	−3.3	75	8	57	32	28	40	32	44	41	80	1.43	−1.3	6	5,582	s.	24	ne.	13	12	6	13	5.5	T	.0
Binghamton	871	60	68	29.12	30.07	+.01	48.2	−1.8	76	11	58	29	28	39	37	.....	.....	.....	1.10	−1.9	9	4,399	nw.	18	sw.	29	8	3	20	7.2	T	.0
New York	314	415	454	29.69	30.03	−.03	53.8	−2.5	74	11	61	35	13	46	24	47	42	68	2.27	−1.3	7	10,937	n.	46	nw.	28	14	7	10	4.6	T	.0
Bellefonte	1,050	5	42	28.95	30.07	.....	49.2	.....	77	16	61	21	20	38	40	43	39	77	1.30	.....	7	.....	sw.	.....	.....	.....	15	6	10	4.9	.5	.0
Harrisburg	374	94	104	29.66	30.06	−.02	53.6	−1.2	78	11	62	32	31	45	30	46	40	67	1.40	−1.5	5	5,520	w.	25	nw.	26	14	7	10	4.8	T	.0
Philadelphia	114	123	367	29.94	30.07	.00	56.0	−1.8	78	11	64	36	20	48	28	48	43	67	1.54	−1.3	5	9,213	n.	33	n.	12	14	6	11	4.7	T	.0
Reading	323	283	306	29.71	30.06	.....	53.8	−.9	77	11	63	33	20	45	31	47	41	67	1.61	−1.5	7	7,911	n.	35	nw	26	13	7	11	5.1	T	.0
Scranton	805	72	104	29.18	30.05	−.02	49.5	−2.4	76	11	59	30	31	40	38	44	39	74	1.06	−2.0	8	5,228	n.	24	nw.	26	10	9	12	5.4	T	.0
Atlantic City	52	37	172	29.99	30.05	−.02	55.6	−1.3	76	11	63	35	13	48	27	50	46	72	1.57	−1.6	5	11,712	w.	35	nw.	28	13	5	13	5.2	T	.0
Sandy Hook	22	10	57	30.01	30.03	.....	54.7	.....	74	11	60	38	13	49	21	49	44	71	2.15	−1.6	7	11,018	w.	37	nw.	12	13	9	9	4.9	T	.0
Trenton	190	88	106	29.84	30.04	.....	53.2	−2.4	77	11	62	34	20	44	30	47	42	71	2.15	−.6	7	6,922	n.	30	nw.	26	13	10	8	4.8	T	.0
Baltimore	123	100	215	29.93	30.06	−.02	57.0	−1.2	81	11	66	36	13	48	32	49	43	65	.95	−1.9	5	7,570	sw.	38	nw.	26	17	3	11	4.2	.0	.0
Washington	112	62	85	29.95	30.07	−.01	56.2	−1.2	81	11	66	35	14	47	38	49	44	70	.75	−2.1	5	4,876	nw.	25	nw.	28	16	6	9	4.5	.0	.0
Cape Henry	18	8	54	30.04	30.06	.....	61.1	−1.0	80	11	68	35	29	54	33	55	51	72	.17	−2.8	1	10,603	n.	44	n.	27	16	7	8	4.0	.0	.0
Lynchburg	686	5	.....	29.85	30.10	+.01	57.8	−.7	83	9	72	29	29	44	47	.....	.....	.....	1.69	−1.5	6	.....	nw.	.....	.....	.....	20	8	3	.....	.....	.0
Norfolk	91	170	205	29.98	30.08	+.01	61.4	−1.1	80	9	69	38	29	54	31	54	50	72	.20	−2.8	3	9,230	ne.	44	nw.	27	16	7	8	4.1	.0	.0
Richmond	144	11	52	29.94	30.09	+.01	58.0	−1.6	80	22	69	32	29	46	38	51	46	74	.82	−2.1	4	5,824	ne.	39	n.	27	16	10	5	3.6	.0	.0
Wytheville	2,304	49	55	27.71	30.10	+.01	53.4	−.2	76	9	65	25	29	42	38	46	42	74	2.07	−.8	5	4,509	w.	27	w.	27	20	6	5	3.1	.0	.0
South Atlantic States							65.1	+0.8										75	3.07	−0.2										3.4		
Asheville	2,253	89	104	27.78	30.13	+.04	57.6	+2.3	79	8	70	26	29	46	37	49	45	76	3.57	+.8	8	5,088	nw.	27	nw.	26	16	9	6	3.9	.0	.0
Charlotte	779	63	86	29.26	30.11	+.03	61.5	−.2	81	9	72	40	30	51	32	53	48	68	4.07	+1.1	5	4,904	ne.	26	sw.	27	21	4	6	3.2	.0	.0
Greensboro	886	6	56	29.15	30.11	.....	57.2	.....	82	9	70	27	29	44	37	50	48	83	1.14	.....	5	5,446	ne.	30	w.	27	19	6	6	3.1	.0	.0
Hatteras	11	5	50	30.03	30.04	−.02	65.4	−.5	83	5	71	44	29	60	23	61	58	78	2.04	−2.9	8	9,566	ne.	32	nw.	28	16	9	6	3.7	.0	.0
Raleigh	376	103	146	29.68	30.08	+.01	60.6	−1.4	81	9	71	34	29	51	32	53	49	71	.61	−2.2	5	6,454	ne.	32	nw.	27	23	3	5	2.7	.0	.0
Wilmington	72	73	107	30.01	30.08	+.02	64.6	−.7	84	6	75	40	29	55	31	57	54	77	.77	−2.5	6	5,679	n.	26	nw.	26	20	5	6	3.1	.0	.0
Charleston	48	11	92	30.02	30.07	+.01	68.7	+.9	87	6	76	49	29	61	26	62	58	75	5.73	+2.5	8	7,713	ne.	30	e.	9	16	7	8	3.7	.0	.0
Columbia, S. C	351	41	57	29.71	30.09	+.02	64.6	+.3	83	7	75	38	29	54	32	56	51	70	2.60	.0	6	4,894	ne.	24	sw.	27	20	5	6	3.4	.0	.0
Greenville, S. C	.....	139	.....	.....	.....	.....	63.2	+3.0	82	7	73	33	29	53	32	.....	.....	.....	3.22	−.1	7	.....	ne.	.....	.....	.....	18	5	8	.....	.....	.0
Augusta	182	62	77	29.88	30.07	.00	66.0	+.7	85	12	77	35	29	55	36	57	53	73	3.73	+1.3	4	3,941	nw.	21	w.	27	17	7	7	3.7	.0	.0
Savannah	65	73	152	29.99	30.06	+.01	70.6	+2.7	92	6	80	48	29	61	30	62	59	78	2.19	−.8	7	6,600	ne.	24	nw.	6	18	4	9	3.9	.0	.0
Jacksonville	43	86	110	29.99	30.04	+.02	73.0	+1.9	89	6	81	50	29	65	28	66	63	81	5.24	+.8	11	5,371	ne.	24	ne.	1	16	10	5	3.7	.0	.0
Florida Peninsula							79.0	+2.2										75	3.23	−2.6										3.9		
Key West	22	10	64	29.94	29.96	+.02	80.6	+1.5	90	6	85	71	16	76	12	74	71	76	3.01	−3.0	8	6,983	ne.	21	nw.	12	14	12	5	4.2	.0	.0
Miami	25	124	168	29.96	29.99	+.02	79.7	+2.7	90	12	85	65	30	74	17	72	69	72	3.14	−5.3	11	7,337	ne.	23	ne.	22	11	13	7	5.1	.0	.0
Tampa	35	88	197	29.97	30.01	+.03	76.7	+2.4	91	7	86	55	29	68	25	69	66	78	3.54	+.4	7	7,889	ne.	24	ne.	14	23	6	2	2.5	.0	.0
Titusville	43	5	36	29.96	30.01	.....	75.6	.....	92	7	86	53	30	66	28	.....	.....	.....	4.11	.....	11	.....	ne.	.....	.....	.....	17	12	2	.....	.0	.0
East Gulf States							69.0	+2.5										75	6.33	+3.4										3.7		
Atlanta	1,173	128	135	28.86	30.10	+.03	64.1	+1.1	81	21	73	40	28	55	28	56	50	68	5.34	+2.8	8	6,571	nw.	29	nw.	27	17	7	7	3.9	.0	.0
Macon	370	79	87	29.68	30.08	+.02	66.1	+1.6	85	23	77	34	29	55	37	57	53	73	3.12	+.8	4	4,750	n.	21	nw.	27	20	5	6	3.4	.0	.0
Thomasville	273	49	58	29.77	30.06	+.02	71.6	+3.4	90	8	83	40	29	61	36	63	59	74	.75	−2.2	8	.....	e.	.....	.....	.....	18	5	8	.....	.0	.0
Apalachicola	36	11	51	29.99	30.03	.....	73.7	.....	87	11	81	48	29	66	28	67	.....	.....	1.39	−1.8	8	.....	ne.	.....	.....	.....	17	10	4	.....	.0	.0
Pensacola	56	149	185	29.98	30.04	+.01	72.4	+2.5	86	12	79	51	29	66	21	65	62	74	20.51	+16.3	5	8,546	ne.	38	s.	5	21	4	6	3.0	.0	.0
Anniston	741	9	.....	.....	.....	.....	63.8	+1.4	85	8	76	34	29	52	34	.....	.....	.....	9.39	+6.8	5	.....	nw.	.....	.....	.....	19	5	7	.....	.0	.0
Birmingham	700	11	48	29.32	30.08	+.01	66.2	+1.4	86	8	77	40	28	56	31	58	54	76	10.95	+8.5	8	4,063	ne.	16	s.	31	15	9	7	4.1	.0	.0
Mobile	57	125	161	29.97	30.03	−.01	71.4	+2.1	86	22	80	47	29	63	29	64	62	79	7.39	+3.8	5	6,386	n.	25	ne.	5	17	7	7	3.8	.0	.0
Montgomery	218	92	105	29.83	30.08	+.02	68.9	+2.3	86	21	78	44	29	59	33	61	57	75	7.95	+5.5	7	4,735	n.	24	nw.	30	17	6	8	4.0	.0	.0
Meridian	375	67	92	29.67	30.07	+.01	68.0	+3.7	90	22	79	42	29	57	36	60	58	82	4.21	+1.8	7	3,591	ne.	17	n.	30	18	7	6	3.5	.0	.0
Vicksburg	247	65	73	29.80	30.06	.00	70.6	+3.9	89	22	80	46	28	61	29	61	57	72	2.44	−.3	2	4,814	n.	15	sw.	31	17	8	6	4.0	.0	.0
New Orleans	53	76	84	29.98	30.03	.00	75.4	+4.4	87	20	82	58	28	69	19	67	64	75	2.53	−.8	3	5,109	ne.	20	n.	5	16	9	6	3.9	.0	.0
West Gulf States							73.1	+5.2										68	0.40	−2.7										2.8		
Shreveport	249	92	227	29.79	30.06	+.01	73.4	+6.8	91	21	84	51	29	62	31	62	55	62	T	−2.7	0	7,482	ne.	29	sw.	31	23	7	1	2.2	.0	.0
Bentonville	1,303	11	44	28.70	30.06	+.01	62.8	+4.8	82	19	76	32	28	49	35	.....	.....	.....	1.34	.....	4	3,609	se.	21	sw.	24	16	10	5	.....	.0	.0
Fort Smith	457	79	94	29.57	30.05	.00	67.0	+4.2	87	19	79	40	29	55	34	57	52	67	.67	−2.3	5	4,954	e.	22	ne.	31	17	11	3	3.2	.0	.0
Little Rock	357	94	102	29.70	30.07	+.01	68.2	+4.6	88	22	79	43	29	57	33	58	52	66	.52	−2.2	3	5,007	e.	25	sw.	31	20	4	7	3.2	.0	.0
Austin	605	136	148	29.39	30.02	.....	75.4	+7.1	92	21	88	50	2	63	36	62	55	58	.03	−3.2	2	5,375	s.	21	s.	31	20	9	2	2.6	.0	.0
Brownsville	57	88	96	29.92	29.98	.....	77.6	+2.7	89	9	86	58	4	69	28	70	68	82	.35	−2.9	5	6,774	se.	24	se.	30	16	12	3	3.5	.0	.0
Corpus Christi	20	11	78	30.01	30.03	+.03	77.4	+4.2	88	5	84	62	2	71	20	70	68	77	1.04	−1.4	3	7,051	se.	23	se.	16	22	5	4	2.8	.0	.0
Dallas	512	220	227	29.48	30.03	.....	72.4	.....	90	20	83	49	28	61	34	60	52	55	.09	−2.6	1	7,635	se.	27	s.	31	24	4	3	2.1	.0	.0
Fort Worth	670	106	114	29.34	30.04	+.01	73.2	+6.5	95	20	85	48	29	61	36	.....	.....	.....	.12	−2.7	1	5,794	se.	24	sw.	31	24	5	2	1.7	.0	.0
Galveston	54	106	114	29.98	30.04	+.01	76.5	+3.8	84	13	81	64	1	72	16	69	66	75	1.56	−2.8	4	6,801	s.	21	sw.	30	21	10	0	2.5	.0	.0
Houston	138	292	314	29.90	30.04	.....	75.6	+5.3	90	21	84	58	3	67	23	.....	.....	.....	T	−3.7	0	8,126	s.	25	s.	30	16	14	1	3.1	.0	.0
Palestine	510	64	72	29.52	30.05	+.02	73.6	+6.4	92	21	85	53	1	62	30	62	56	65	.37	−3.0	3	4,954	s.	18	sw.	31	21	7	3	2.5	.0	.0
Port Arthur	34	58	66	29.99	30.03	.....	75.0	.....	87	21	83	57	2	67	24	67	64	78	.32	−3.0	2	5,389	n.	25	n.	25	15	16	0	3.5	.0	.0
San Antonio	693	242	301	29.29	30.00	−.01	76.4	+5.9	93	5	87	57	3	66	28	65	59	63	.19	−2.0	2	7,745	se.	27	e.	16	18	9	4	3.4	.0	.0

TABLE 1.—*Climatological data for weather bureau stations, October 1934*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with .01 or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Ohio Valley and Tennessee	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	*°F.*	*°F.*	*°F.*		*°F.*	*°F.*		*°F.*	*°F.*	*°F.*	*°F.*	*%*	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
							59.3	+1.3										69	1.32	−1.4										3.6		
Chattanooga	762	71	214	29.29	30.10	+0.01	63.6	+1.7	83	8	75	35	29	52	32	56	52	74	4.36	+1.4	8	4,689	ne.	24	nw.	27	15	11	5	3.6	0.0	0.0
Knoxville	995	102	111	29.05	30.11	+.02	61.6	+1.7	81	8	73	33	29	50	32	53	49	74	4.36	+1.7	7	3,812	ne.	21	w.	27	19	6	6	3.4	.0	.0
Memphis	399	76	97	29.65	30.08	+.01	67.6	+4.3	87	22	77	39	28	58	28	58	52	66	1.11	−1.6	5	4,640	e.	21	sw.	31	18	9	4	3.2	.0	.0
Nashville	546	168	191	29.52	30.11	+.03	63.4	+2.4	83	9	75	35	28	52	35	54	49	67	2.02	−.5	6	5,885	ne.	33	nw.	27	14	9	8	4.0	.0	.0
Lexington	989	5																													
Louisville	525	188	234	29.53	30.11	+.03	60.4	+1.1	82	11	71	34	28	49	32	51	45	64	.52	−2.1	4	6,648	n.	41	nw.	27	18	9	4	3.1	.0	.0
Evansville	431	76	116	29.62	30.10	+.02	62.4	+3.0	83	9	73	33	28	51	30	53	47	67	.85	−2.0	6	5,455	e.	27	nw.	27	17	8	6	3.4	.0	.0
Indianapolis	822	194	230	29.21	30.10	+.03	58.0	+2.3	82	9	69	30	28	47	29	49	42	61	.19	−2.6	1	7,645	s.	34	nw.	27	15	12	4	3.5	.0	.0
Terre Haute	575	96	129	29.47	30.09		59.2		81	11	71	31	28	48	32	51	46	69	.43	−2.3	3	6,376	s.	24	nw.	27	19	7	5	2.9	.0	.0
Cincinnati	627	11	51	29.42	30.11	+.03	57.8	+2.1	83	11	70	31	28	46	38	48	40	66	.35	−2.2	2	5,126	ne.	28	sw.	21	16	10	5	3.6	.0	.0
Columbus	822	216	230	29.22	30.10	+.02	56.0	+.8	80	10	67	32	30	45	34	47	41	65	.26	−2.2	2	7,712	sw.	41	w.	27	14	12	5	3.7	.0	.0
Elkins	1,947	59	78	28.07	30.15	+.05	50.8	−1.5	79	9	64	23	14	37	48	43	40	79	1.52	−1.4	7	4,374	w.	34	w.	27	14	10	7	4.6	T	.0
Parkersburg	637	77	84	29.47	30.14	+.06	55.4	−.7	80	9	68	28	30	43	42	48	44	73	.49	−2.0	3	4,337	se.	31	nw.	27	16	10	5	3.6	.0	.0
Pittsburgh	842	353	410	29.18	30.10	+.02	54.6	−1.1	79	9	64	31	14	45	34	47	42	71	.67	−1.8	7	6,915	w.	37	nw.	27	14	5	12	4.6	T	.0
Lower Lake Region							50.9	−1.2										72	1.50	−1.4									5.5		
Buffalo	768	243	280	29.20	30.04	−.01	50.4	−1.5	73	25	57	29	28	44	25	45	41	74	1.51	−1.8	8	11,886	w.	43	sw.	6	8	11	12	5.6	.4	.0
Canton	448	10	61	29.52	30.01		44.0	−3.2	73	17	54	23	14	34	36				3.11	+.1	11	6,425	sw.	30	sw.	31	8	7	16	6.4	.7	.0
Ithaca	836	77	100	29.14	30.05		48.8	−2.3	75	17	58	29	28	40	34	43	40	77	1.66	−1.3	13	6,831	nw.	27	nw.	28	6	8	17	6.7	.7	.0
Oswego	335	71	85	29.66	30.03	−.02	48.5	−2.7	76	17	55	30	20	42	29	44	38	70	1.77	−1.5	11	8,182	n.	30	nw.	28	7	7	17	6.7	T	.0
Rochester	523	86	102	29.48	30.06	+.01	50.1	−1.4	80	17	57	31	20	43	28	44	39	70	1.79	−.9	12	6,672	sw.	24	w.	11	10	6	15	6.0	1.0	.0
Syracuse	596	65	79	29.41	30.06	.00	49.4	−1.6	78	17	57	29	28	42	35				1.66	−1.2	10	5,815	w.	24	nw.	28	6	9	16	6.9	1.2	.0
Erie	714	130	166	29.28	30.06	+.01	52.0	−1.4	74	17	59	31	28	45	29	46	41	71	1.89	−1.8	8	10,246	n.	35	w.	11	14	7	10	4.9	3.7	.0
Cleveland	762	267	337	29.24	30.07	+.01	53.7	+.1	76	16	61	34	29	47	26	47	41	66	.99	−1.8	8	11,073	sw.	58	w.	27	11	10	10	5.2	T	.0
Sandusky	629	5	67	29.40	30.09	+.03	54.3	.0	80	8	64	30	30	45	33				.98	−1.5	6	6,875	sw.	32	nw.	27	9	14	8	5.0	T	.0
Toledo	628	79	87	29.40	30.09	+.04	53.5	+.1	81	11	62	31	30	45	29	46	41	70	.50	−1.9	6	7,045	w.	30	nw.	27	17	5	9	4.0	T	.0
Fort Wayne	857	69	84	29.16	30.09		54.1	+.4	78	11	64	29	30	44	30	47	42	72	.82	−1.8	4	6,485	sw.	30	nw.	27	15	10	6	4.0	T	.0
Detroit	626	5	78	29.38	30.08	+.03	52.2	−.3	82	11	62	28	14	43	34	45	41	74	1.33	−1.0	6	7,719	sw.	28	nw.	6	15	5	11	4.9	T	.0
Upper Lake Region							49.9	+1.5										77	2.02	−0.7									5.6		
Alpena	609	13	89	29.37	30.04	+.01	47.0	−.1	69	14	55	27	19	39	38	43	39	79	1.57	−1.1	8	8,902	nw.	34	se.	20	13	7	11	5.3	1.6	.0
Escanaba	612	54	60	29.36	30.03	+.02	47.6	+1.6	72	11	55	25	30	40	26	43	40	77	1.77	−.9	6	8,188	s.	30	nw.	27	6	10	15	6.4	T	.0
Grand Rapids	707	70	244	29.29	30.06	+.02	52.4	+1.2	77	16	61	32	19	44	27	46	41	72	2.27	−.5	6	8,439	w.	30	nw.	27	13	8	10	4.8	T	.0
Lansing	878	6	88	29.12	30.07		49.6	−.7	78	16	59	27	30	40	34	45	42	82	1.53	−.9	6	7,144	w.	26	w.	6	13	6	12	5.1	T	.0
Ludington	637	5	54	29.34	30.05		50.8	+1.1	73	11	58	29	19	44	27	45			1.82	−1.1	6		nw.				8	10	13		T	.0
Marquette	734	77	111	29.19	30.00	−.01	48.0	+1.3	81	14	55	29	30	41	33	44	40	79	.93	−1.8	11	8,174	w.	34	s.	1	8	6	17	6.7	1.0	T
Sault Sainte Marie	614	11	52	29.32	30.03	+.02	45.6	+1.0	67	5	53	28	19	38	31	41	38	79	1.99	−1.8	11	7,595	nw.	40	nw.	6	7	7	17	6.6	1.3	.3
Chicago	673	7	131	29.34	30.07	+.03	56.0	+2.0	81	11	63	31	30	48	26	49	45	71	2.32	−.2	3	7,873	w.	35	nw.	27	15	9	7	4.0	T	.0
Green Bay	617	109	141	29.36	30.03	+.01	51.2	+2.7	80	11	60	25	30	42	32	44	40	72	1.60	−.9	4	8,350	w.	30	nw.	27	8	7	16	6.5	T	.0
Milwaukee	681	97	221	29.32	30.05	+.02	54.0	+2.9	84	11	61	30	30	48	27	47	43	72	2.28	−.1	3	10,017	w.	40	nw.	27	12	9	10	4.9	T	.0
Duluth	1,133	5	47	28.76	29.99	−.01	47.2	+3.1	79	14	55	23	31	39	37	42	39	83	4.17	+1.9	9	10,122	nw.	43	nw.	27	10	7	14	6.1	T	.0
North Dakota							49.4	+5.6										67	1.21	0.0									5.2		
Moorhead, Minn	940	50	58	28.96	29.99	−.01	49.6	+5.1	84	10	60	21	31	40	43	43	38	72	2.07	+.4	5	6,648	s.	28	nw.	5	8	9	14	5.9	T	.0
Bismarck	1,674	8	57	28.20	30.00	+.01	50.9	+6.0	87	11	62	19	31	39	42	42	34	62	.86	−.1	3	6,745	nw.	31	w.	5	9	12	10	5.4	T	.0
Devils Lake	1,478	11	44	28.41	30.00	+.01	47.1	+4.7	87	13	57	19	31	37	40	40	36	74	1.89	+.6	8	7,297	nw.	34	n.	16	9	6	16	6.1	T	.0
Grand Forks	833	12	67				48.0		86	10	58	21	31	38	42	42			4.21		7		nw.	34	nw.	16	9	4	18		T	.0
Williston	1,878	41	48	28.01	30.00	+.02	50.0	+6.6	85	12	62	13	31	38	41	41	34	61	.01	−.8	1	6,209	se.	38	nw.	5	18	8	5	3.4	T	.0
Upper Mississippi Valley							57.6	+4.4										70	2.23	−0.2									3.7		
Minneapolis	918	102	208	29.01	30.00		54.0	+5.1	81	11	62	28	31	46	34	46	41	66	5.64	+3.6	8	8,877	se.	32	nw.	26	10	8	13	5.8	T	T.
La Crosse	714	11	48	29.25	30.02	.00	54.1	+3.8	84	11	64	27	31	44	36	47	43	74	2.38	+.1	4	4,587	s.	19	nw.	27	12	10	9	4.8	T	.0
Madison	974	70	78	28.99	30.05	+.02	53.8	+3.5	81	11	62	28	30	45	26	47	43	73	2.27	−.2	4	7,032	w.	30	nw.	27	16	4	11	4.5	T	.0
Charles City	1,015	10	51	28.96	30.04	+.02	54.0	+5.4	83	11	65	24	31	43	37	46	42	73	1.36	−1.0	3	5,973	se.	26	sw.	16	16	10	5	3.6	T	.0
Davenport	606	66	161	29.41	30.07	+.03	58.0	+4.3	82	11	68	30	28	48	28	50	45	69	1.77	−.6	4	7,143	sw.	25	nw.	27	16	8	7	4.0	.0	.0
Des Moines	861	5	99	29.13	30.04	+.01	58.2	+4.8	86	8	70	28	28	47	38	50	45	70	1.67	−.8	3	7,183	s.	30	nw.	27	20	6	5	2.9	.0	.0
Dubuque	700	60	79	29.30	30.05	+.01	56.0	+4.1	84	11	66	31	28	46	34	48	42	68	1.20	−1.3	2	4,823	s.	22	nw.	27	16	9	6	4.1	.0	.0
Keokuk	614	64	78	29.40	30.08	+.03	59.1	+3.7	82	8	70	29	28	49	29	51	45	67	1.93	−.3	3	5,449	sw.	23	sw.	20	20	4	7	3.1	.0	.0
Cairo	358	87	93	29.70	30.08	+.01	63.7	+3.3	84	12	74	36	28	53	33	55	50	71	2.68	−.1	5	5,087	n.	33	nw.	24	18	5	8	3.5	.0	.0
Peoria	609	11	45	29.42	30.09	+.04	57.4	+5.4	83	9	69	27	28	46	33	49	45	74	1.97	−.3	4	4,815	s.	19	nw.	27	24	2	5	2.3	.0	.0
Springfield, Ill	636	5	191	29.40	30.08	+.03	60.1	+4.3	82	10	71	31	28	49	31	51	46	70	1.64	−.9	4	8,347	s.	34	nw.	24	22	3	6	3.1	.0	.0
St. Louis	568	265	303	29.47	30.07	+.01	63.2	+4.9	82	23	73	36	28	53	30	53	47	64	2.23	−.5	6	8,081	s.	32	n.	27	21	4	6	2.8	.0	.0
Missouri Valley							60.0	+5.7										64	1.64	−0.6									3.2		
Columbia, Mo	784	6	84	29.24	30.08	+.03	61.0	+4.4	82	26	72	29	28	50	34				2.57	.0	6	5,486	s.	27	n.	27	17	9	5	3.4	.0	.0
Kansas City	750	32	45	29.24	30.05	+.01	63.0	+5.3	87	8	75	31	30	51	36	54	49	69	1.88	−1.0	6	6,360	sw.	27	sw.	16	19	7	5	3.2	.0	.0
St. Joseph	967	11	49	29.01	30.04		61.9		87	8	73	29	28	51	34	52	47	66	1.66	−1.0	6	5,735	se.	29	w.	20	21	6	4	2.8	.0	.0
Springfield, Mo	1,324	98	104	28.68	30.08	+.03	63.3	+5.1	83	23	73	34	28	53	36	54	48	65	1.30	−1.8	4	6,302	se.	25	n.	27	20	8	3	2.6	.0	.0
Iola	984	11	50	29.02	30.05	+.01	63.2	+5.4	84	12	76	29	28	51	35				1.92	−1.1	6		s.				19	8	4		.0	.0
Topeka	987	65	87				62.9	+5.9	88	8	75	31	28	51	35				1.91	−.5	8	6,264	s.	27	s.	16	20	9	2	2.6	.0	.0
Lincoln	1,189	11	81	28.76	30.02	−.01	60.2	+6.0	90	8	72	27	30	48	35	50	44	64	1.93	.0	5	7,240	s.	29	n.	27	20	9	2	2.9	.0	.0
Omaha	1,105	170	200	28.85	30.03	.00	60.8	+6.5	91	8	72	30	29	50	32	51	44	60	1.92	−.2	6	8,319	s.	36	s.	16	21	6	4	2.8	.0	.0
Valentine	2,598	47	54	27.32	30.04	+.03	54.4	+5.1	90	7	68	21	31	40	47	44	36	58	1.26	+.2	7	7,035	w.	33	se.	15	17	7	7	3.7	.0	.0
Sioux City	1,138	64	106	28.80	30.01	−.01	57.8	+6.9	86	7	70	23	30	46	41	49	43	66	1.24	−.5	5	7,157	se.	30	sw.	16	18	4	9	3.8	.0	.0
Huron	1,306	60	74	28.61	30.02	+.01	53.9	+6.2	88	11	66	23	31	42	43	45	39	66	.41	−.9	6	7,349	se.	28	w.	5	18	6	7	3.7	.1	.0

TABLE 1.—*Climatological data for weather bureau stations, October 1934*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with .01 or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F.*		°*F.*	°*F.*		°*F.*	°*F.*	°*F.*	°*F.*	%	*In.*	*In.*		*Miles*								*0-10*	*In.*	*In.*
Northern Slope							**50.8**	**+5.6**										**60**	**0.92**	**−0.1**										**4.7**		
Billings	3,140	4																													
Havre	2,505	11	67	27.37	30.02	+0.04	49.2	+4.7	87	11	62	20	31	37	48	41	34	65	0.67	0.0	7	6,932	sw.	30	sw.	20	9	15	7	5.0	1.5	0.0
Helena	4,124	85	111	25.84	30.04	+.01	48.8	+3.9	78	6	58	27	27	39	35	42	36	67	1.05	+.2	12	6,110	sw.	32	s.	7	4	9	18	6.9	2.0	.0
Kalispell	2,973	48	56	26.98	30.06	+.05	46.2	+2.7	76	10	55	30	4	38	35	42	37	75	2.26	+1.2	8	4,115	w.	24	w.	12	7	4	20	7.1	T	.0
Miles City	2,371	48	55	27.49	30.05	+.05	52.6	+6.1	86	11	65	24	27	41	45	42	33	53	.03	−.9	2	4,689	s.	27	nw.	5	12	13	6	4.4	.0	.0
Rapid City	3,259	50	58	26.64	30.05	+.04	54.5	+6.0	89	7	67	25	31	42	41	44	35	55	1.67	+.7	5	6,641	w.	32	nw.	16	17	12	2	3.3	.0	.0
Cheyenne	6,094	50	71	24.08	30.02	+.01	51.6	+6.8	80	7	65	30	30	38	45	38	26	43	T	−1.0	0	8,558	w.	38	w.	24	17	11	3	3.3	T	.0
Lander	5,372	60	68	24.71	30.06	+.02	51.4	+7.9	80	7	66	29	29	36	44	40	30	52	.72	−.6	3	4,081	sw.	24	w.	7	19	8	4	3.5	.0	.0
Sheridan	3,790	10	47	26.13	30.04	------	50.6	------	82	7	65	25	30	37	46	41	34	65	1.49	+.4	8	4,264	nw.	21	nw.	8	15	11	5	3.9	.0	.0
Yellowstone Park	6,241	11	48	23.97	30.10	+.08	46.0	+4.5	75	11	58	22	23	34	41	37	31	64	1.00	−.4	12	6,034	sw.	27	sw.	7	5	10	16	6.6	1.9	.0
North Platte	2,821	11	51	27.10	30.02	.00	57.2	+7.5	92	7	72	26	29	42	50	40	38	60	.30	−.8	4	5,827	w.	28	s.	3	20	6	5	3.4	.0	.0
Middle Slope							**62.2**	**+6.3**										**53**	**1.03**	**−0.7**										**2.8**		
Denver	5,292	106	113	24.79	30.01	0.00	57.8	+6.6	87	7	71	35	27	44	36	42	26	34	T	−1.0	0	5,841	s.	29	nw.	8	16	13	2	3.4	0.0	0.0
Pueblo	4,685	80	86	25.36	30.02	+.03	59.2	+7.2	91	7	75	27	28	43	50	43	26	35	.01	−.6	1	5,558	nw.	30	sw.	15	19	11	1	3.2	.0	.0
Concordia	1,392	50	58	28.58	30.06	+.03	62.4	+6.5	91	8	75	28	28	50	38	51	44	61	.75	−1.2	4	6,096	s.	27	sw.	16	21	7	3	2.7	.0	.0
Dodge City	2,509	10	86	27.46	30.05	+.03	62.4	+6.3	91	7	76	33	28	49	39	50	42	59	1.50	+.2	2	8,968	s.	38	s.	15	21	7	3	2.2	.0	.0
Wichita	1,358	85	93	28.61	30.04	+.01	64.2	+5.6	84	8	74	37	30	54	28	54	48	63	1.89	−.7	8	7,599	s.	28	sw.	23	22	5	4	2.6	.0	.0
Oklahoma City	1,214	10	47	28.78	30.05	+.02	67.0	+5.5	84	23	78	36	28	56	33	57	51	67	2.03	−.8	7	6,506	s.	21	s.	15	20	8	3	2.8	.0	.0
Southern Slope							**70.0**	**+6.8**										**49**	**0.67**	**−1.2**										**2.0**		
Abilene	1,738	10	52	28.23	30.01	.00	73.1	+7.7	95	5	87	42	28	59	43	56	46	48	.18	−2.3	2	6,818	s.	27	s.	23	27	3	1	1.4	.0	.0
Amarillo	3,676	10	49	26.33	30.02	+.02	66.0	+8.3	95	8	80	34	28	52	39	50	38	46	.21	−1.4	3	6,749	s.	27	s.	15	22	6	3	2.3	.0	.0
Big Spring	2,537	5	62	27.42	30.02	------	70.2	------	95	5	85	42	28	55	42	54	45	51	.11	------	3	------	s.	------	------	------	24	7	0	1.5	.0	.0
Del Rio	944	64	71	28.98	29.96	−.02	74.8	+4.8	95	6	86	53	25	64	33	63	56	60	1.83	.0	2	6,093	se.	30	e.	16	19	9	3	2.9	.0	.0
Roswell	3,566	75	85	26.42	29.99	+.03	65.9	+6.4	94	5	82	39	29	50	46	50	36	41	.47	−1.0	4	5,490	s.	29	sw.	15	23	7	1	1.8	.0	.0
Southern Plateau							**64.2**	**+4.2**										**43**	**0.23**	**−0.4**										**2.2**		
El Paso	3,778	152	175	26.24	29.97	+.05	69.4	+5.9	93	6	83	45	26	56	38	51	36	36	.44	−.4	2	6,006	w.	49	nw.	11	27	0	4	1.5	.0	.0
Albuquerque	4,972	5	39	25.14	30.00	------	66.0	------	85	6	75	31	24	42	45	46	38	54	.24	−.6	4	5,434	n.	32	nw.	23	22	6	3	2.3	.0	.0
Santa Fe	7,013	38	53	23.37	30.02	+.06	54.3	+3.9	76	8	67	33	24	42	33	41	29	44	.23	−1.0	3	4,708	e.	22	sw.	15	21	4	6	3.1	.0	.0
Flagstaff	6,907	10	59	23.44	29.99	+.07	50.3	+5.6	80	8	68	20	24	32	46	38	----	52	.04	------	1	6,324	n.	30	sw.	14	16	14	1	----	.0	.0
Phoenix	1,108	10	107	28.77	29.90	+.02	75.5	+4.9	103	6	92	48	24	60	45	55	40	34	.00	−.5	0	4,066	e.	20	s.	14	21	7	3	2.5	.0	.0
Yuma	141	9	54	29.75	29.89	+.02	76.2	+2.9	107	1	93	49	20	60	44	59	46	40	.00	−.3	0	3,927	n.	21	n.	23	24	7	0	1.7	.0	.0
Independence	3,957	5	26	26.00	30.04	+.09	59.8	+2.3	89	10	75	33	15	44	41	45	----	----	.47	+.1	2	------	s.	----	----	----	22	3	6	----	.0	.0
Middle Plateau							**54.4**	**+4.1**										**45**	**0.80**	**0.0**										**3.7**		
Reno	4,527	61	76	25.54	30.04	+.05	54.0	+4.3	86	10	69	27	23	40	43	43	32	50	1.09	+.7	5	4,459	w.	24	w.	6	16	8	7	4.0	.0	.0
Tonopah	6,090	12	20	------	------	------	54.0	------	77	9	64	28	23	44	30	41	27	39	1.22	------	2	------	se.	----	----	----	----	----	----	----	----	----
Winnemucca	4,344	18	56	25.68	30.07	+.02	51.8	+3.5	87	11	68	22	23	35	50	41	31	53	.87	+.2	7	5,905	ne.	28	s.	21	15	8	8	4.3	T	.0
Modena	5,473	10	46	24.68	30.01	+.05	51.9	+3.9	80	6	69	27	24	35	45	39	26	44	.55	−.2	3	7,019	w.	36	sw.	18	19	5	7	3.2	.0	.0
Salt Lake City	4,360	86	210	25.70	30.06	+.05	56.2	+3.7	82	2	68	33	20	44	32	44	33	47	1.48	.0	6	4,939	s.	27	s.	7	14	12	5	4.1	T	.0
Grand Junction	4,602	60	68	25.45	30.03	+.04	57.9	+5.1	84	7	73	31	24	43	41	42	28	38	.03	−.9	2	4,630	se.	35	s.	15	21	7	3	2.7	.0	.0
Northern Plateau							**53.6**	**+4.0**										**60**	**1.52**	**+0.4**										**6.1**		
Baker	3,471	48	53	26.50	30.09	+.01	49.7	+3.1	85	11	62	30	22	38	42	43	36	63	1.52	+.6	8	5,068	se.	26	sw.	25	6	11	14	6.1	T	.0
Boise	2,739	79	87	27.22	30.08	+.02	54.4	+3.3	82	1	66	33	23	43	35	46	38	58	1.07	−.2	10	3,799	se.	22	se.	21	10	3	18	6.1	.0	.0
Pocatello	4,477	60	68	25.54	30.06	+.02	54.5	+6.1	84	11	67	32	23	42	41	42	31	49	.65	−.5	6	6,719	se.	29	s.	21	13	11	7	4.6	.0	.0
Spokane	1,929	101	110	27.99	30.05	−.01	51.4	+3.1	84	10	61	33	19	42	34	45	40	69	3.45	+2.3	13	4,729	s.	24	sw.	23	6	5	20	7.0	T	.0
Walla Walla	991	57	65	28.96	30.03	−.04	56.4	+2.9	88	9	65	32	16	48	33	49	42	61	1.57	.0	11	3,933	s.	21	s.	23	6	7	18	7.0	.0	.0
Yakima	1,076	58	67	28.88	30.03	------	55.4	+5.2	85	10	65	35	19	46	33	48	40	61	.89	+.3	7	4,236	nw.	27	sw.	21	10	7	14	6.0	.0	.0
North Pacific Coast Region							**55.5**	**+3.1**										**76**	**5.25**	**+1.4**										**6.5**		
North Head	211	11	56	29.77	29.99	−.06	54.2	+1.3	67	9	59	42	16	50	20	51	49	87	7.76	+2.8	18	11,576	s.	87	se.	21	10	7	14	6.3	.0	.0
Seattle	125	90	321	29.86	29.99	−.06	55.2	+3.8	77	9	62	41	18	48	23	51	47	76	3.62	+.8	16	6,575	se.	59	s.	21	9	6	16	6.3	.0	.0
Tatoosh Island	86	10	54	29.87	29.97	−.04	52.4	+2.5	66	10	56	45	22	49	14	50	48	88	8.28	+.2	21	11,272	e.	60	s.	19	6	5	20	7.4	.0	.0
Medford	1,329	29	58	28.63	30.04	------	55.6	------	92	10	70	28	16	41	49	48	40	64	2.48	+1.1	8	4,187	nw.	35	se.	21	8	9	14	5.8	.0	.0
Portland, Oreg	153	68	106	29.85	30.01	−.05	57.4	+3.2	85	10	66	42	16	49	30	52	48	72	5.30	+2.2	15	4,890	nw.	24	s.	21	8	6	17	6.9	.0	.0
Roseburg	510	45	76	29.48	30.04	−.04	58.5	+4.6	96	10	70	37	13	47	46	52	46	70	4.04	+1.4	11	3,074	sw.	32	w.	31	7	10	14	6.2	.0	.0
Middle Pacific Coast Region							**60.5**	**+1.5**										**67**	**1.77**	**+0.3**										**4.8**		
Eureka	62	73	89	29.99	30.06	.00	55.2	+1.6	72	30	62	40	16	49	22	52	50	87	3.98	+1.6	12	4,766	se.	31	n.	13	8	8	15	6.4	.0	.0
Redding	722	20	34	------	------	------	65.0	------	98	9	76	42	22	54	38	52	40	48	2.96	------	8	5,401	nw.	27	s.	6	13	6	12	5.1	.0	.0
Sacramento	69	92	115	29.93	30.00	+.01	64.6	+1.7	93	10	77	44	23	52	37	55	47	59	.45	−.5	4	5,346	s.	27	n.	14	19	9	3	2.9	.0	.0
San Francisco	155	208	243	29.86	30.02	+.01	61.8	+1.3	87	9	69	50	28	55	28	55	51	74	.88	−.2	4	4,784	w.	24	n.	14	13	7	11	4.9	.0	.0
South Pacific Coast Region							**66.1**	**+1.8**										**67**	**1.49**	**+0.9**										**3.7**		
Fresno	327	97	105	29.64	30.00	+.04	66.0	+2.0	96	10	79	42	23	53	35	55	46	54	1.74	+1.2	5	3,954	nw.	21	nw.	22	21	3	7	3.0	.0	.0
Los Angeles	338	159	191	29.62	29.99	+.04	67.5	+2.2	92	25	77	53	19	58	29	57	52	67	2.31	+1.6	4	3,981	sw.	20	se.	17	18	6	7	3.6	.0	.0
San Diego	87	62	70	29.88	29.97	+.02	64.9	+1.2	81	25	71	53	23	59	23	60	57	80	.42	−.1	4	4,714	nw.	23	s.	17	17	4	10	4.5	.0	.0
West Indies																																
San Juan, P. R	82	9	54	29.86	29.94	------	80.6	+.8	92	13	87	71	3	74	17	----	----	----	4.73	−1.1	14	6,132	s.	25	e.	19	3	24	4	5.5	.0	.0
Panama Canal																																
Balboa Heights	118	6	97	------	[1] 29.86	+.04	78.5	−.7	90	1	84	71	21	73	16	----	----	[1] 90	11.44	+1.4	25	3,415	nw.	24	ne.	13	0	10	21	8.2	.0	.0
Cristobal	36	6	97	------	[1] 29.85	+.03	80.3	+.5	89	3	86	73	14	75	15	76	75	[1] 85	17.49	+1.9	25	3,620	se.	26	nw.	27	0	6	25	8.5	.0	.0
Alaska																																
Fairbanks	454	11	87	[2] 29.08	[2] 29.60	------	31.3	------	56	3	38	7	26	24	28	29	24	70	.21	------	9	3,639	ne.	21	se.	3	0	5	26	9.0	4.0	T
Juneau	80	96	116	[2] 29.67	[2] 29.76	------	44.0	------	56	8	48	28	28	40	22	42	39	82	12.30	------	25	5,916	se.	28	se.	8	2	3	26	8.7	T	.0
Hawaiian Islands																																
Honolulu	38	86	100	[2] 29.97	[2] 30.01	------	78.1	+1.3	87	17	83	70	29	74	12	72	69	75	1.61	+.1	15	6,793	e.	25	e.	19	17	11	3	3.9	.0	.0

[1] Observations taken hourly.

[2] Pressure not reduced to mean of 24 hours.

TABLE 2.—*Data furnished by the Canadian Meteorological Service, October 1934*

Station	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max.+ mean min.÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*Inches*	*Inches*	*Inch*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*Inches*	*Inches*	*Inches*
Cape Race, N. F.	99				47.8		53.4	42.3	64	35	7.10		0.0
Sydney, C. B. I.	48	29.82	29.87	−0.09	49.1	+2.6	55.3	42.9	67	33	8.60	+3.91	.0
Halifax, N. S.	88	29.66	29.76	−.24	48.9	+1.7	54.2	43.7	67	34	4.20	−1.35	.0
Yarmouth, N. S.	65	29.80	29.87	−.15	49.2	+1.6	55.7	42.7	67	31	3.40	−.72	T
Charlottetown, P. E. I.	38	29.82	29.86	−.10	47.4	+.9	52.6	42.2	66	31	1.76	−3.14	.0
Chatham, N. B.	28	29.81	29.84	−.12	42.6	−.4	50.6	34.5	68	25	2.81	−1.05	.0
Father Point, Que.	20												
Quebec, Que.	296	29.64	29.97	−.03	42.1	−.3	47.5	36.7	59	28	2.21	−.94	3.8
Doucet, Que.	1,236				35.3		43.4	27.2	67	8	3.07		9.4
Montreal, Que.	187												
Ottawa, Ont.	236	29.75	30.02	+.01	44.9	+1.1	54.0	35.9	73	24	2.02	−.53	.7
Kingston, Ont.	285	29.70	30.01	−.02	47.0	.0	54.1	39.9	67	29	1.67	−1.06	T
Toronto, Ont.	379	29.63	30.04	.00	48.6	+2.0	55.9	41.2	73	28	1.33	−1.03	.2
Cochrane, Ont.	930				37.6		45.0	30.2	67	18	3.29		5.8
White River, Ont.	1,244	28.64	29.97	−.01	38.6	+1.5	47.9	29.3	63	7	1.88	−.47	.3
London, Ont.	808				47.4		57.4	37.3	73	20	2.34		9.6
Southampton, Ont.	656	29.31	30.03	+.01	46.6	+.5	54.6	38.6	72	25	2.25	−.92	1.6
Parry Sound, Ont.	688	29.32	30.02	+.01	45.0	+1.1	52.5	37.6	69	22	3.00	−.92	5.9
Port Arthur, Ont.	644	29.27	29.98	.00	45.3	+5.4	52.1	38.5	76	21	4.15	+1.59	1.4
Winnipeg, Man.	760	29.15	29.98	.00	45.4	+0.3	54.1	36.7	82	19	.42	−1.28	T
Minnedosa, Man.	1,690	28.16	30.00	+.03	44.0	+6.2	55.3	32.8	84	10	.21	−.99	T
Le Pas, Man.	860		29.98		40.4		49.2	31.6	75	15	.72		2.8
Qu'Appelle, Sask.	2,115	27.68	29.93	−.04	44.5	+5.1	55.9	33.1	86	11	.05	−1.05	.0
Moose Jaw, Sask.	1,759				46.3		59.2	33.3	90	8	.15		.0
Swift Current, Sask.	2,392	27.40	29.93	−.04	46.3	+4.2	58.8	33.8	86	12	.27	−.61	.0
Medicine Hat, Alb.	2,365	27.42	29.91	−.06	48.1	+3.3	60.0	36.3	88	21	.25	−.33	.9
Calgary, Alb.	3,540	26.25	29.94	−.01	42.9	+2.8	54.0	31.9	85	18	.56	+.08	5.6
Banff, Alb.	4,521	25.38	29.98	+.03	41.7	+2.4	51.6	31.8	77	18	.92	−.10	7.5
Prince Albert, Sask.	1,450	28.41	30.00	+.03	41.8	+4.7	53.0	30.7	85	12	.18	−.65	1.0
Battleford, Sask.	1,592	28.22	29.97	.00	42.4	+2.8	56.8	28.1	87	1	.03	−.42	.2
Edmonton, Alb.	2,150												
Kamloops, B. C.	1,262	28.74	30.04	+.08	49.7	+2.7	57.9	41.6	85	28	.34	−.27	.0
Victoria, B. C.	230	29.72	29.97	−.04	52.4	+3.2	57.8	47.0	72	42	2.34	−.03	.0
Barkerville, B. C.	4,180												
Estevan Point, B. C.	20				50.5		55.6	45.3	65	34	13.81		.0
Prince Rupert, B. C.	170				47.2		53.0	41.4	62	34	12.57		.0
Hamilton, Bermuda	151												

SEVERE LOCAL STORMS, OCTOBER 1934

[Compiled by Mary O. Souder]

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path (yards)	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Milltown, Wis., vicinity of	5		33–880	0	$10,000	Tornado	3 persons seriously injured; farmhouse, 2 cottages, barn and several other buildings demolished; livestock killed; path 5 miles long.	Official, U. S. Weather Bureau.
Polk and Barron Counties, Wis., northern portions.	5	5–6 p. m.		0	35,000	Wind	Most of the damage from this storm occurred in the vicinity of Cumberland where several buildings were demolished and livestock killed.	Do.
New England, northern portion.	13–14			0		Snow and wind	This storm the most severe early blizzard in New England's history; in Presque Isle the strong wind accompanying the storm uprooted giant shade trees still brilliant with autumn foliage and felled 200 telephone poles, 100 electric light and power poles; the unharvested potato crop in Aroostook County, Maine, threatened with possible loss.	Do.
Tripp County, S. Dak.	15	10 p. m.	[1] 6–8	0	14,000	Thundersquall	Damage to farm buildings, trees and telephone poles; path several miles long.	Do.
Los Angeles, Calif., and vicinity.	17–18			8	200,000	Heavy rain, flood, and earthquake.	Many streets in Los Angeles and surrounding towns flooded; over 3 inches of rain fell in Long Beach shattering a 15-year record; more than 50 homes damaged and several wrecked; huge wall of water swept out of foothills and through the towns of La Crescenta, Montrose, and Glendale; 6 persons killed in accidents attributed to the storm and 2 boys drowned; hundreds of persons forced to evacuate their homes.	Do.
Minneapolis and St. Paul, Minn.	19–20			0	65,000	Excessive rain	Considerable damage in the Twin Cities mainly to creosote block pavements; estimated loss in Minneapolis to street paving $50,000 and in St. Paul $15,000; additional unestimated damage from flooding of basements.	Do.

[1] Miles instead of yards.

SEVERE LOCAL STORMS, OCTOBER 1934—Continued

Place	Date	Time	Width of path (yards)	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Washington, entire State	21			22	1,700,000	Wind and rain	This storm one of the most severe of record in this State; maximum velocity of 87 miles recorded at North Head; large areas of forests were uprooted and broken; many buildings blown down, others unroofed and some moved from their foundations; highways impassable because of fallen trees, poles and wires; railway trains and buses delayed for several hours; transportation by airplane interrupted; in the Strait of Juan de Fuca, in Puget Sound and on Lake Washington the waves were 20 feet or more in height; damage to docks, wharfs and piers amounted to thousands of dollars; several barges, tugboats, a number of fishing boats and many small pleasure craft were lost; ferry service discontinued during the storm, the ferry boats taking refuge in sheltered harbors; greatest damage to timber, which was estimated to be $500,000, occurred near Gold Bar.	Official, U. S. Weather Bureau.
Maryville, Mo., 5 miles southwest.	23	5:15 p. m.	100–133	5	900,000	Tornado	5 members of C. C. C. camp killed; 16 persons seriously injured; damage $800,000 to $1,000,000 over a path 14 miles long; storm accompanied by little rain; haystacks and corn fodder shocks blown away; no other crop damage reported; a dime was found wedged in a tree trunk and a 10-foot plank was driven through the chassis and steel body of an overturned automobile.	Do.
Chicago, Ill	24	P. m.		0		Rain	Streets and passages under viaducts flooded in many places.	Do.
Conway, Ark	24			0	750	Electrical	Barn destroyed after being struck by lightning	Do.
Grand Rapids, Mich	24			0	1,900	Thunderstorm	House struck by lightning and damaged	Do.
Pittsburgh, Pa	27	1–8:22 p. m.		0		Rain, sleet, and snow.	Snow adhered to wind shields making driving difficult.	Do.
Richmond, Va	27	7–9 p. m.	[1] 10	0	2,000	Wind	Branches of trees blown off; several small buildings and a schoolhouse unroofed; plate-glass window blown in.	Do.
Cleveland, Ohio, and vicinity	27–28			0	2,000	Gale, rain, and sleet.	Signs and wires blown down; maximum wind velocity of 58 miles, highest ever recorded in Cleveland for October.	Do.
Detroit, Mich	28			2		Wind	Fishing boat in lower Detroit River capsized and 2 men drowned; occupants of several other small boats in the vicinity rescued by Coast Guards.	Do.
Monroe, Mich	28			0		do	The freighter *Marita* went aground outside the harbor at Monroe due to wind blowing the water away from shore lowering the water level from 6 to 8 feet.	Do.
Hart, Green, Taylor, Casey, Pulaski, Rockcastle, Laurel, Liberty, Leitchfield, and Christian Counties, Ky.	31	3–7:30 p.m.	400–1,760	6	350,000	Tornadic winds and heavy hail.	Estimated loss in Casey and Pulaski Counties $102,075, of which $40,000 resulted from flooded lowlands along the creeks; Green County: 30 to 40 barns destroyed; Taylor County: 57 homes and 25 barns damaged or destroyed, 63 persons homeless, 6 persons injured; considerable livestock killed; Casey County: 3 churches, 4 school houses, 125 dwellings and barns damaged or destroyed, 1 person killed and 24 injured; Laurel County: 5 persons burned to death in their home; Pulaski County: 2 houses and 2 barns destroyed, 2 persons injured; damage from hail was reported in Liberty, Casey, and Leitchfield Counties; Christian County considerable damage to telephone and telegraph lines.	Do.
Nashville, Tenn	31	A. m.		0		Thunderstorm and hail.	Barn and corncrib destroyed by fire after being struck by lightning; farm hand injured.	Do.

[1] Miles instead of yards.

Correction: June 1934 Mo. Wea. Review, page 217: Loss of life in the Greensburg, Kans., tornado, June 8, should be "0"; width of path should be "33 yards".

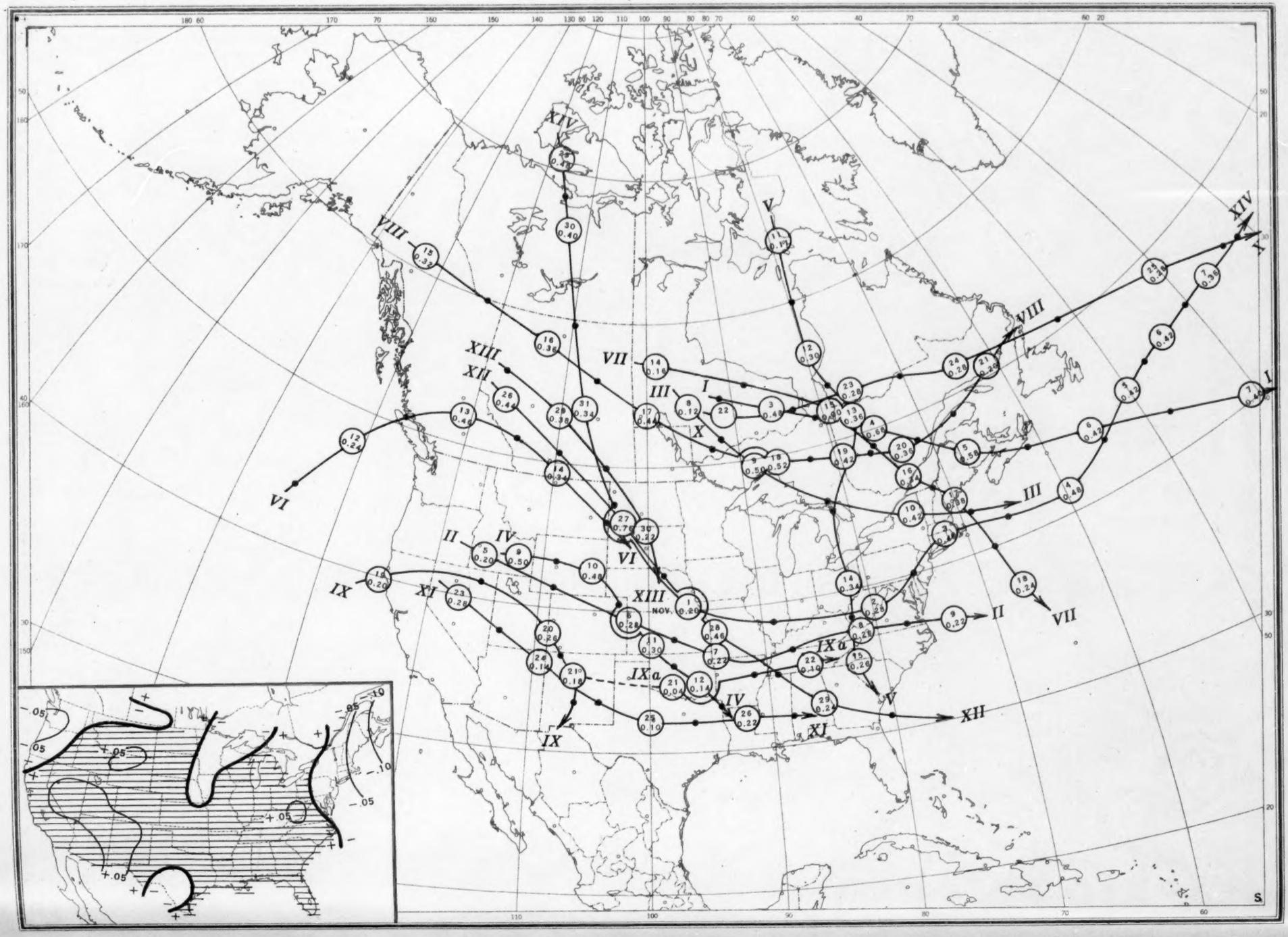
Chart I. Departure (°F.) of the Mean Temperature from the Normal, October 1934

Chart I. Departure (°F.) of the Mean Temperature from the Normal, October 1934

Shaded portions show excess (+)
Unshaded portions show deficiency (−)
Lines show amount of excess or deficiency
Statute Miles
Kilometers

Chart II. Tracks of Centers of Anticyclones, October 1934. (Inset) **Departure of Monthly Mean Pressure from Normal**

(Plotted by G. E. Dunn)



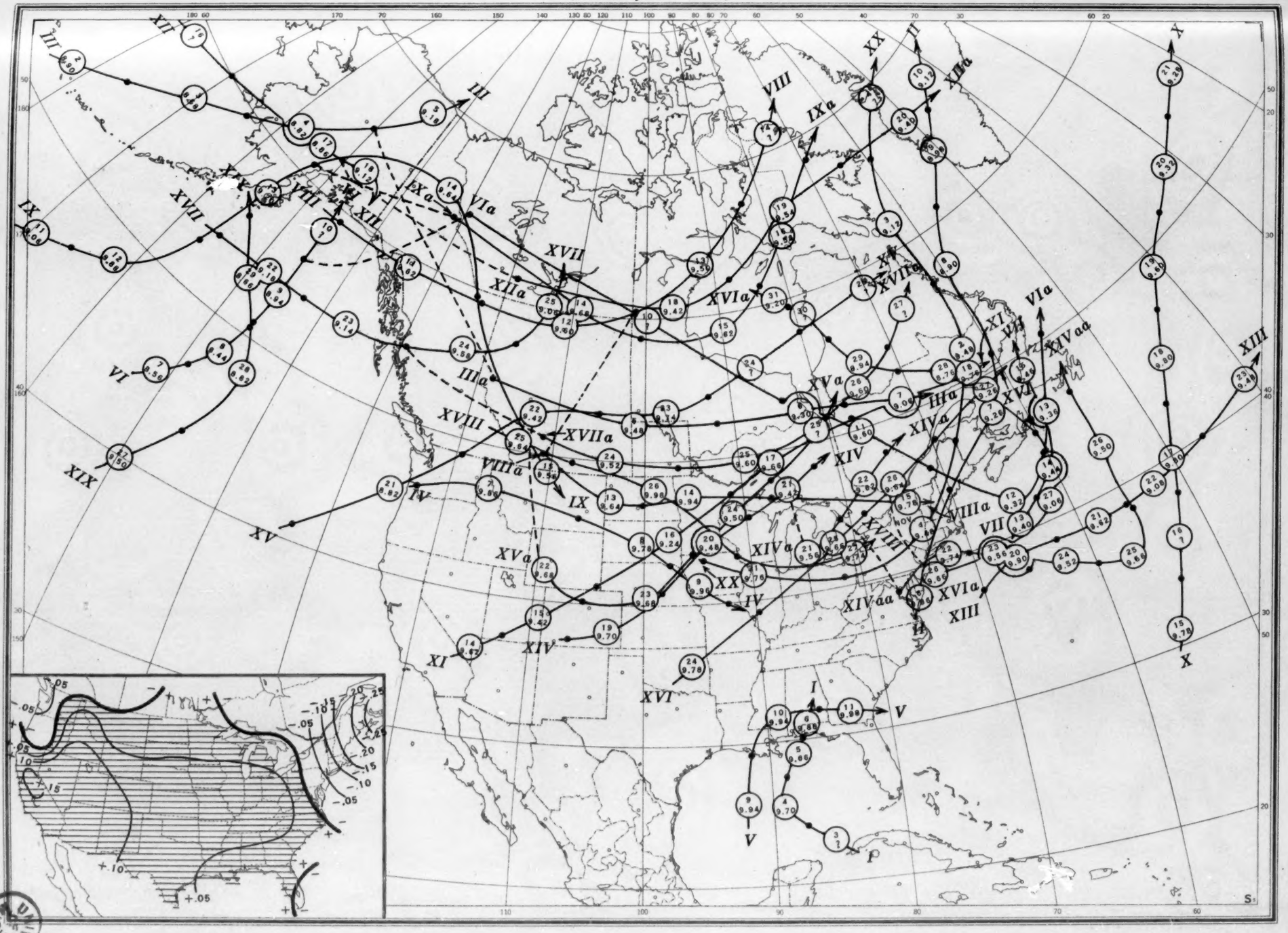
Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, October 1934. (Inset) **Change in Mean Pressure from Preceding Month**

Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, October 1934. (Inset) **Change in Mean Pressure from Preceding Month**

(Plotted by G. E. Dunn)



Circle indicates position of cyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 8 p. m. (75th meridian time).

Chart IV. Percentage of Clear Sky Between Sunrise and Sunset, October 1934

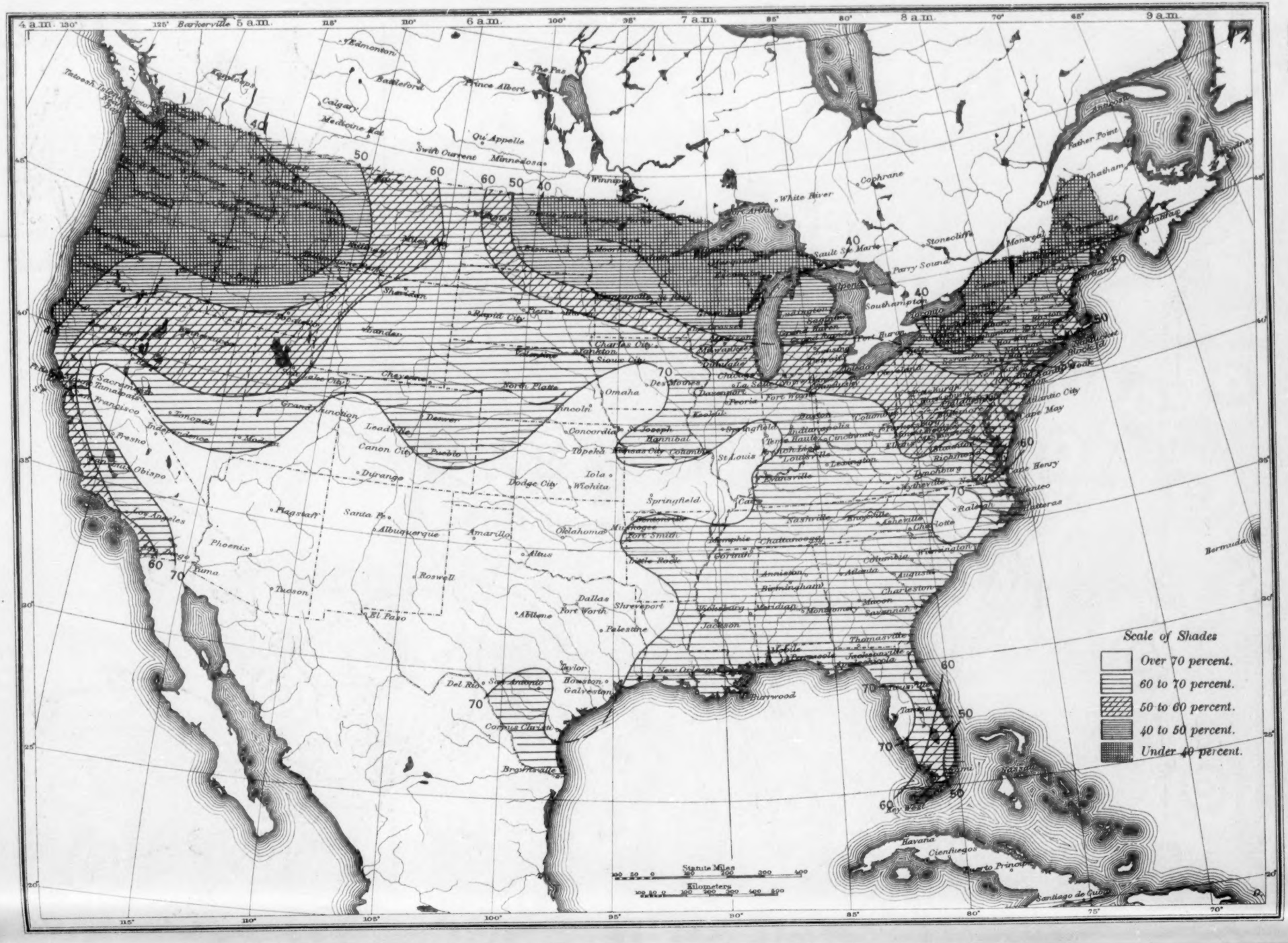


Chart V. Total Precipitation, Inches, October 1934. (Inset) Departure of Precipitation from Normal

Chart V. Total Precipitation, Inches, October 1934. (Inset) Departure of Precipitation from Normal

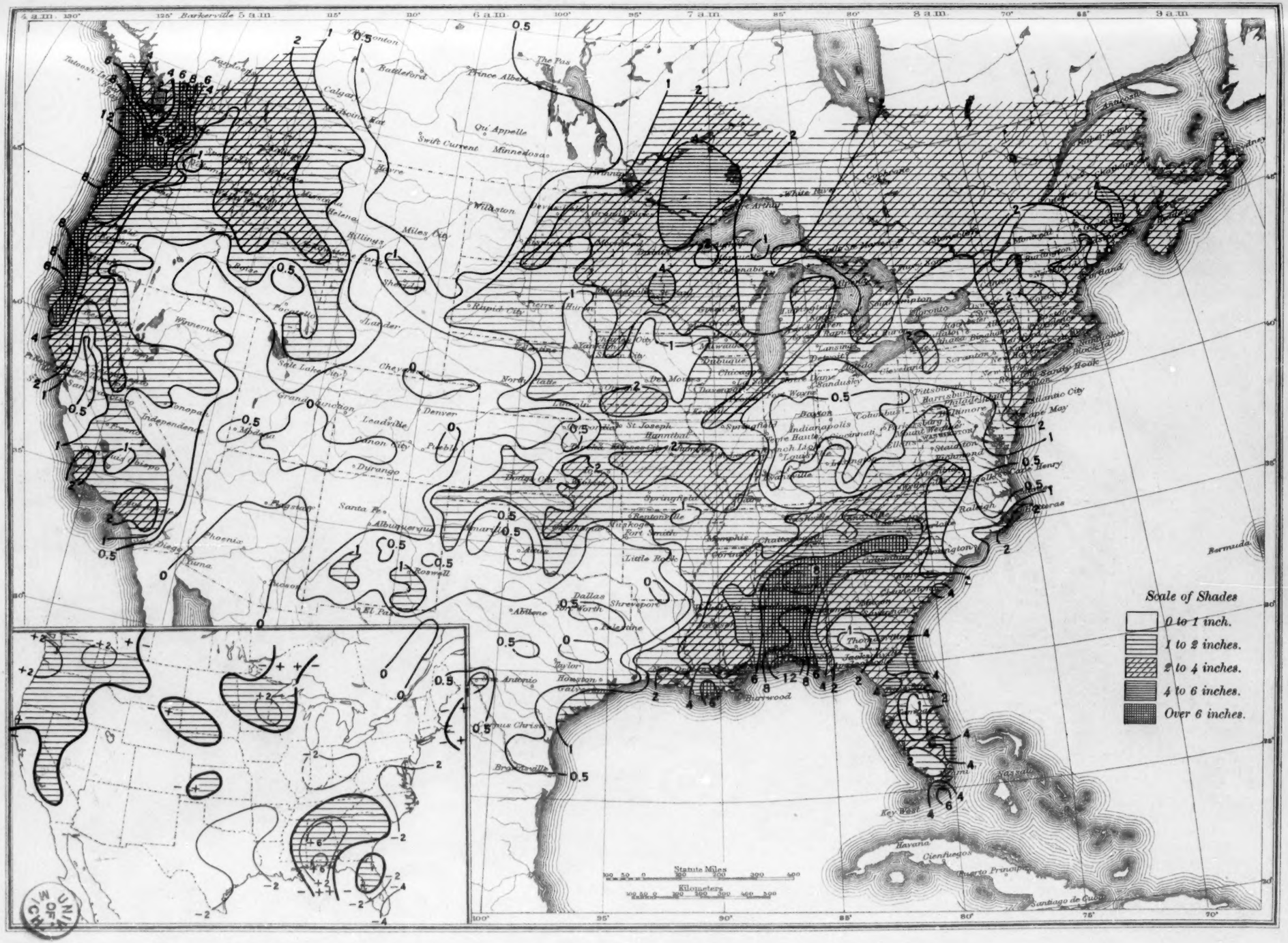


Chart VI. Isobars at Sea Level and Isotherms at Surface; Prevailing Winds, October 1934

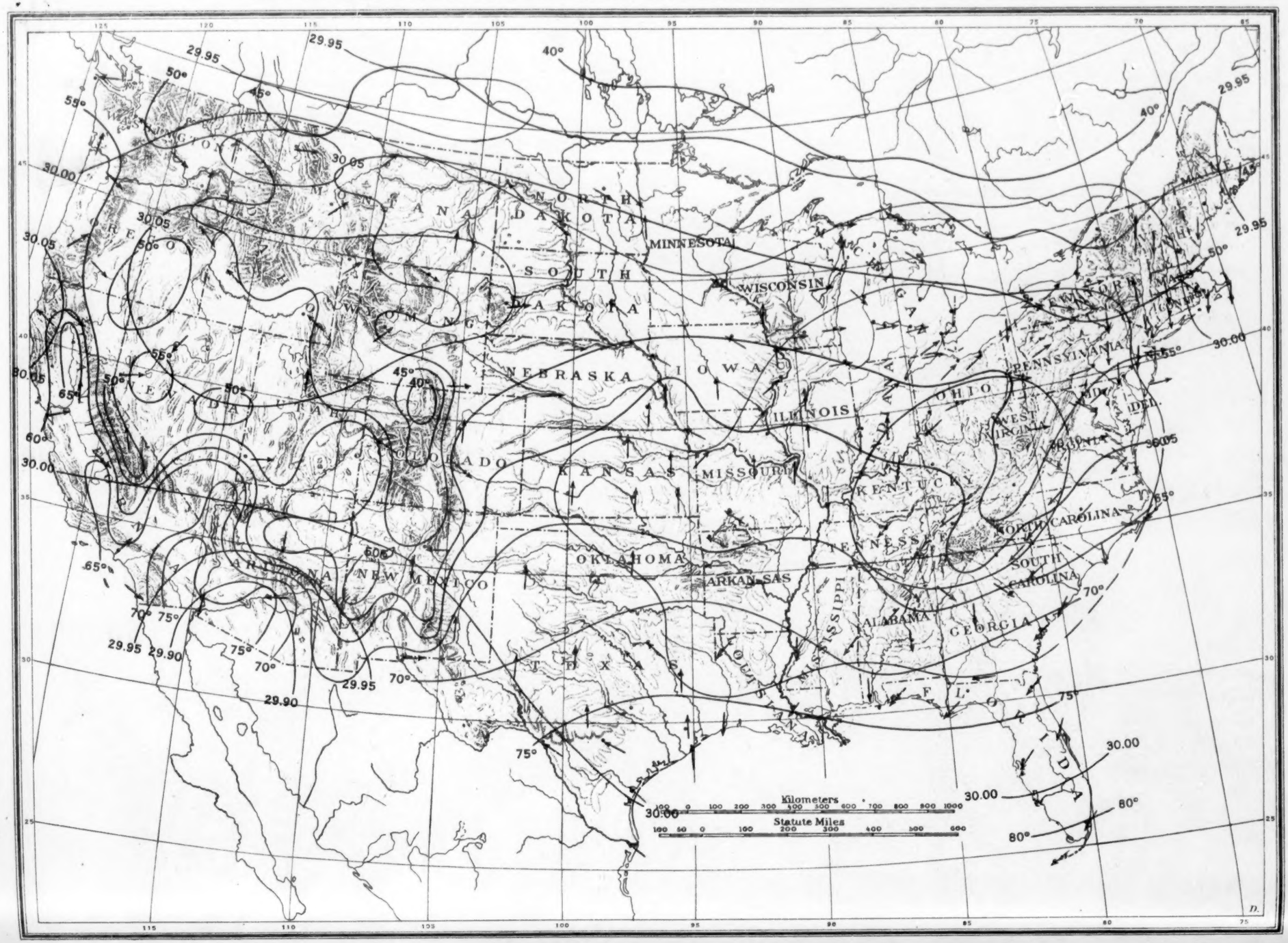


Chart VIII. Weather Map of North Atlantic Ocean, October 5, 1934

(Plotted from the Weather Bureau Northern Hemisphere Chart)

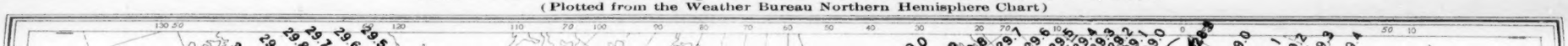
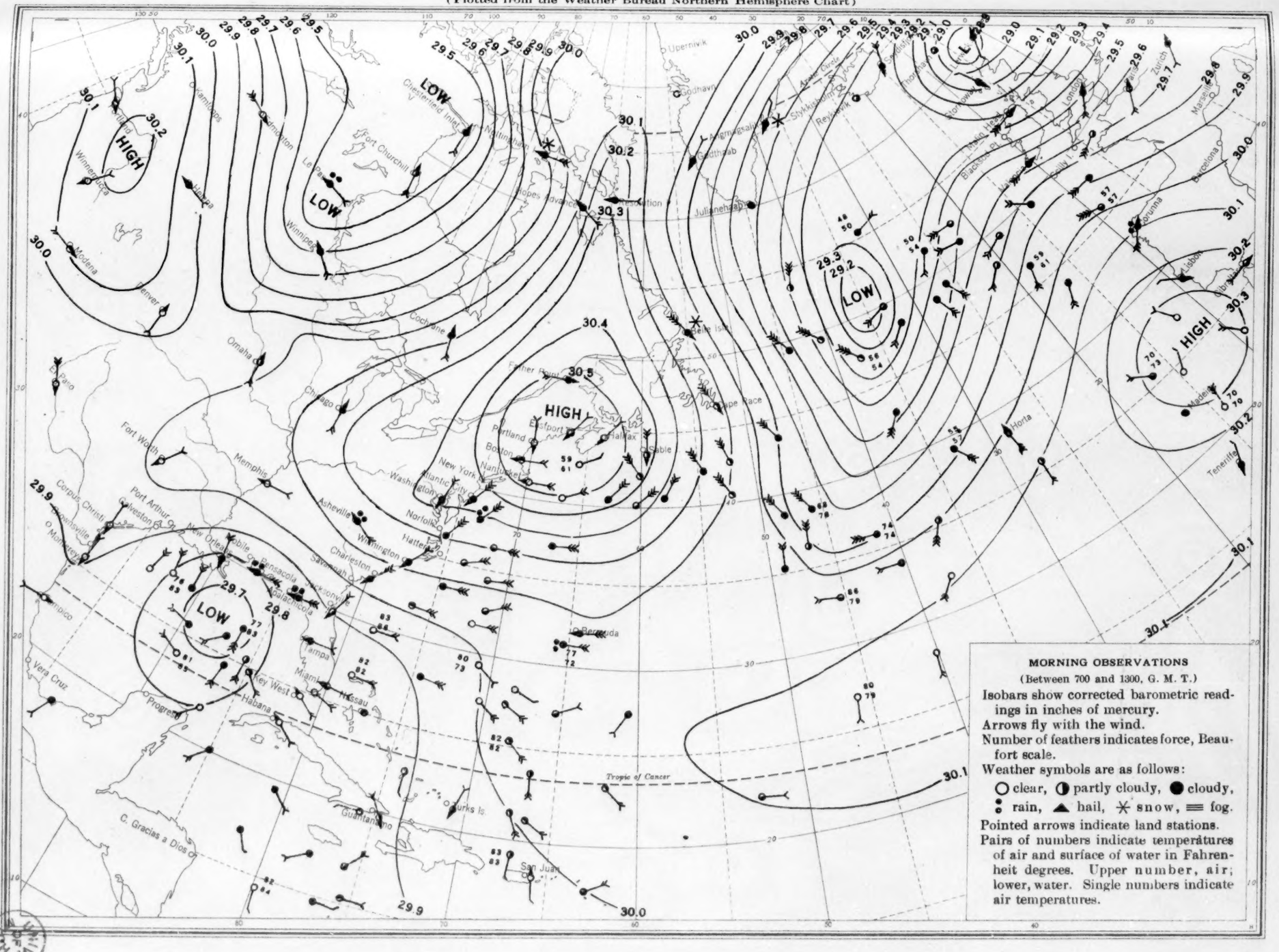
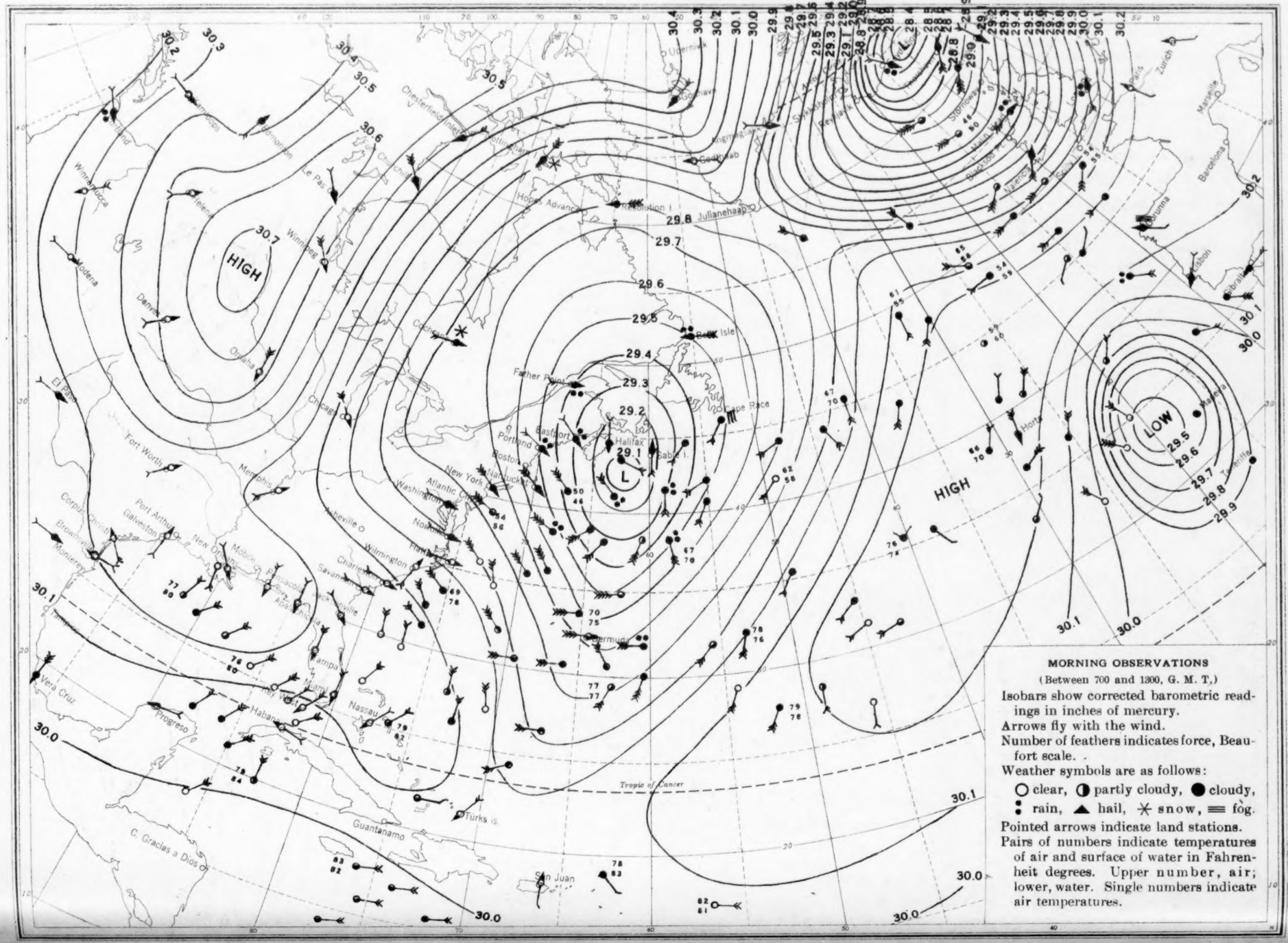


Chart VIII. Weather Map of North Atlantic Ocean, October 5, 1934
(Plotted from the Weather Bureau Northern Hemisphere Chart)



MORNING OBSERVATIONS
(Between 700 and 1300, G. M. T.)

Isobars show corrected barometric readings in inches of mercury.
Arrows fly with the wind.
Number of feathers indicates force, Beaufort scale.
Weather symbols are as follows:
○ clear, ◑ partly cloudy, ● cloudy, ⁚ rain, ▲ hail, ✳ snow, ≡ fog.
Pointed arrows indicate land stations.
Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water. Single numbers indicate air temperatures.

Chart IX. Weather Map of North Atlantic Ocean, October 27, 1934

(Plotted from the Weather Bureau Northern Hemisphere Chart)